HERPETOLOGICA

Established 1936. Organ of the HERPETOLOGISTS LEAGUE,
A.A.A.S. Associate. Society of Systematic Zoology Affiliate.

President, Dr. Hobart M. Smith. Vice-President, Dr. Angus M. Woodbury.
Secretary-Treasurer and Publisher, Chapman Grant,
Route 1, Box 80, Escondido, California

Edited by the Officers. Policies determined by the Members. $4.00 per volume

Vol. 11 July 15, 1955 Part 2

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Report on a Small Collection of Amphibians from Veracruz, with a Description of a New Species of *Pseudoeurycea*

By FREDERICK A. SHANNON *and* JOHN E. WERLER

The following amphibians were part of a collection made by John Werler, Jack Reid, and Bob Roberts between February 4 and 19, 1953, and by the above collectors and Donald M. Darling between January 17 and February 7, 1954. The major portion of the collection from the Los Tuxtlas Range in the State of Veracruz, Mexico, is being reported elsewhere.

Abbreviations used in the text are as follows: FAS=F. A. Shannon herpetological collection; UIMNH=University of Illinois Museum of Natural History. Thanks are due Ellen Shannon for the illustration, Fig. 1. The photograph for Fig. 2 was taken by John E. Werler.

Thorius dubitus Taylor

Only one specimen of this little salamander (FAS 4781) was taken from two miles west of Acultzingo, Veracruz, at an altitude of 7000 feet.

While the suborbital groove intersects the line of the mouth almost as far posteriorly as the posterior corner of the eye, the specimen is otherwise remarkably like Taylor's (1941: 108) type description. The strong lateral compression of the tail immediately distinguishes the species from either *troglodytes* or *pennatulus*, although Taylor's other distinguishing characteristics are almost as good. Although a male, the dorsum of the head is not at all pitted, a character in keeping with Taylor's description. A single premaxillary tooth pierces the lip.

Thorius troglodytes Taylor

Two specimens, FAS 4779 ♀ and 4784 ♂, are from two miles west of Acultzingo, Veracruz, taken at an altitude of 7000 feet.

Both specimens closely follow Taylor's (1941: 110) type description. They may be told from *dubitus* at a glance because of their lighter color-

ation and their fat, widened tails. Both have the suborbital groove bisection of the line of the mouth at a point slightly posterior to the posterior corner of the eye. The male has a strongly pitted head and the subnarial swellings are somewhat greater than those of *dubitus*. The female's head is not nearly so strongly pitted as that of the male.

While both *troglodytes* and *dubitus* have oval nostrils, there is a difference which is hard to define, those of *troglodytes* being a little more rounded and slightly larger.

Pseudoeurycea firscheini sp. nov.*

Holotype. FAS 4714 (Fig. 1), collected 2 miles W of Acultzingo, Veracruz, by John Werler and Jack Reid, between Feb. 4 and Feb. 19, 1953, at an altitude of 7000 feet.

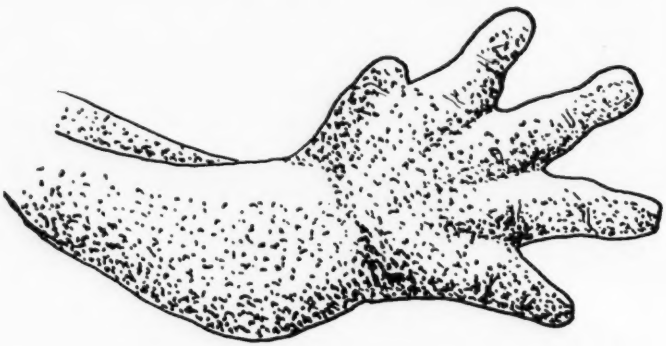

FIG. 1. Dorsal view of right foot of holotype of *Pseudoeurycea firscheini*.

Paratypes. FAS 4175 (Fig. 2) and UIMNH 21807 and 25103 are also from 2 miles W of Acultzingo, Veracruz, same time, same collectors, and like the holotype are from the mountain crest.

Diagnosis. Resembling *P. nigromaculata* in general form and dental formulae, differing in possession of a uniform darker ground color, with few if any of the dark spots typical of *nigromaculata*. Similar to *leprosa* in coloration, except that *firscheini* is distinctly darker dorsally and lacks the light colored chin of *leprosa*. The hind feet of *firscheini* are half again as big as a similarly-sized *leprosa*. From *cephalica* it differs in the

* After Mr. I. Lester Firschein, whose earlier explorations on Volcan San Martin have done much toward stimulating interest in this region of Mexico.

possession of long, slender toes which are half or less webbed compared to the fat, more than half webbed toes of *cephalica*.

Description of holotype. Head slightly wider (7 mm.) than long; diameter of eye (2.9 mm.) slightly greater than distance from eye to nostril, about as wide as internarial distance and interorbital space; nostrils small; nasolabial groove fine but distinct; vertical groove behind corner of mouth extending dorsally to above corner of eye and curving back sharply in a V to join and continue posteriorly as a midvertebral groove; point of junction of V near level of nuchal arms of gular fold; canthus indistinct and rounded.

FIG. 2. *Pseudoeurycea firscheini*, paratype, FAS 4175.

Tongue oval, small, fleshy, attached to stalk in front and free on sides and rear; vomerine teeth in curving, barely separated patches; premaxillary-maxillary teeth distinct; paravomerine teeth separated from vomerine teeth by a narrow space slightly greater than that between internal nares and vomerine teeth; paravomerine teeth in two diverging rows. Maxillary-premaxillary teeth, 42-44; vomerine teeth 16-18; mandibular teeth, 42 (?)-42.

Costal grooves 14 in number, including an axillary and inguinal groove; grooves approaching but not crossing midline; limbs not adpressed due to brittleness of specimen (adpressed limbs of 4175 separated by slightly more than two intercostal spaces); fingers less than half webbed; phalangeal formula 3-2-4-1; foot large; toes slender, phalangeal formula, 3-4-2-5-1; toes slightly more than 1/3 webbed; tail small, obviously regenerated; snout-vent length, 47.2 mm.

Dorsal coloration in alcohol dark purplish brown, apparently uniform, but disclosing occasional darker spots on submersion. Venter fairly uniformly brown pigmented but considerably lighter than dorsum; pigment more scattered under chin which is nevertheless quite dark.

The other three specimens are remarkably similar to the holotype. UIMNH 21807 is somewhat lighter but completely lacks darker pig-

mentation even when submerged. UIMNH 25103 is a juvenile with a probably complete tail; total length, 47 mm.; snout-vent length, 22.6 mm.

As pointed out by Smith, Smith, and Werler (1952: 253), these individuals may possibly be intergrades between *P. leprosa* and *P. nigromaculata,* with *leprosa* representing the high mountain form and *nigromaculata* the low. The feet of *firscheini* are somewhat intermediate between the sparsely webbed, long toes of *nigromaculata* and the more heavily webbed, shorter toes of *leprosa.* The color pattern of *firscheini* is darker than that of either *leprosa* or *nigromaculata* but is intermediate in the sense that the dorsal color resembles that of *leprosa,* the ventral color that of *nigromaculata.* The belly of *nigromaculata,* while not as dark as that of *firscheini,* is darker than the back. The reverse is true of *firscheini.*

All the specimens of *firscheini* were secured from water-filled, urn-shaped bromeliads growing on trees at heights of from 7 to 20 feet above ground, while the type series of *nigromaculata* were found in a terrestrial habitat.

In life, the most prominent features of marking and color of the adults in this series were the small, lichen-like spots on the tail. These were of irregular shapes and sizes, light in color, and haphazardly arranged on the tail. Due to caudal regeneration the holotype showed only a single lichen-like caudal marking. Ventrolaterally, the body became darker, almost black. The feet were tan with irregular dark markings.

Leptodactylus melanonotus (Hallowell)

Fifteen specimens are represented as follows: FAS 4093-96 from 18 miles SE of Alvarado, Veracruz, February 8, 1953; FAS 4098-4108 from 15-20 miles SW of Minatitlan, Veracruz, February 9, 1953. All of these frogs were taken under logs and stones along the edge of ponds or marshland, always where the soil was damp.

The dorsal surfaces of all are more or less distinctly ridged with about a dozen longitudinal rows composed of linear pustular elevations. These surfaces are dark with a variable number of indistinct black spots. Femoral surfaces are strongly banded anteriorly, spotted posteriorly. Ventral surfaces are light, thickly suffused with brown spots or marbling. The area over the belly may be fairly free of this darker coloration.

A posttympanic gland is fairly distinct in the larger specimens. Postaxillary and postfemoral glands not noted. The largest specimen (No. 4094) has a snout-vent length of 39.5 mm.

Acrodytes modesta Taylor and Smith

An adult female (FAS 4080) from 14.4 miles NW of Alvarado, Veracruz, was collected February 8, 1953.

The specimen represents a state record and northward extension of the range. Taylor and Smith (1945: 596) record an example from Tenosique, on the Gulf drainage of Tabasco.

The toad has a snout-vent length of 55.4 mm. and does not deviate markedly from the type description (Taylor and Smith, 1945: 594). The back is light brown in color as is the Tabasco specimen. This is somewhat different from the lavender-brown to purplish-brown of Chiapas specimens; black punctate markings distinct on dorsum of femur and

tibia; similar black punctations present on whole of lateral body surfaces from groin to near tympanum.

Hyla bistincta bistincta Cope

Two adults, FAS 4718-19 and four juveniles, FAS 4081-82 and 4176-77, from W Acultzingo, Veracruz, elevation 7000 feet.

As these tree toads were probably taken near the type locality of *bistincta* (Lake San Bernardino, Acultzingo, Veracruz, by restriction of Smith and Taylor, 1950: 346) a few remarks are in order.

Finger digital formula 3-4-2-1; first finger reaches slightly farther than web of second; fingers slightly webbed at base; toe formula 4-3-5-2-1; third and fifth toes subequal; first and second toes almost fully webbed; web between third and fourth and between fourth and fifth toes ¾ length of third and fifth toes.

Back uniformly dark; sides cream with dark reticulations from above shoulder to groin; yellow marbling on thighs anteriorly and posteriorly; yellow markings on dorso-posterior aspect of femur of smaller specimen in form of longitudinal band. Largest specimen 52 mm. from snout to vent.

The femoral pattern of the juveniles is different from that of the adults and is not dissimilar from that of *H. eximia.*

The specimens were found, individually, in wet bromeliads high in trees.

Rana pipiens austricola Cope

A single specimen, FAS 4077, was collected 18 miles SE of Alvarado, Veracruz.

A tentative character (head width slightly greater than head length) offered by one of us (Shannon, 1951: 479) breaks down with the specimen at hand. The frog is otherwise consistent with Smith's (1947: 409) redescription of the subspecies.

LITERATURE CITED

Shannon, F. A.
1951. Notes on a herpetological collection from Oaxaca and other localities in Mexico. Proc. U. S. Nat. Mus., 101 (3284): 465-481, figs. 91-93.

Smith, H. M.
1947. Notes on Mexican amphibians and reptiles. Jour. Wash. Acad. Sci., 37:408-412.

Smith, P. W., H. M. Smith, and John E. Werler
1952. Notes on a collection of amphibians and reptiles from eastern Mexico. Texas Jour. Sci., no. 2: 251-260, pl. 1.

Taylor, E. H.
1941. Herpetological miscellany, No. II. Univ. Kans. Sci. Bull., Pt. 1 (7):105-139, pl. 3-6, 7 text figs.

Taylor, E. H., and H. M. Smith
1945. Summary of the collections of amphibians made in Mexico under the Walter Rathbone Bacon travelling scholarship. Proc. U. S. Nat. Mus., 95 (3185):521-613, pls. 18-32, figs. 58-61.

WICKENBURG, ARIZONA AND SAN ANTONIO, TEXAS

Intraspecific Variation in Compression of Tail in a Cuban Lizard, *Anolis lucius*

By HOBART M. SMITH and EDWARD T. WILLIS, JR.

Two anoles secured by the junior author in Cuba have led us to a re-evaluation of the character of the tail in the species represented, *Anolis lucius* Duméril and Bibron. We are greatly indebted to Dr. Max Hecht for pointing out the existence of a hitherto unrecorded variation.

The original authors (1837, in Erp. Gen., 4:105), Boulenger (1885, Cat. Liz. Brit. Mus., 2:45), and Barbour and Ramsden (1919, Mem. Mus. Comp. Zool. 47:138) agree in describing *Anolis lucius* as having a round (in cross-section) or weakly compressed tail. The single male collected by Willis on the contrary possesses a strongly compressed tail with a feeble fin. Comparison of such specimens with descriptive accounts reveals such a disparity that conspecificity might not even be suspected (as was true originally in our own case). Material made available through the courtesy of Mr. Arthur Loveridge and Dr. Ernest Williams reveals, however, that in *A. lucius* the tail varies from a nearly round to strongly compressed shape even in males of the same size. The tail in females and juveniles is nearly or quite round in cross-section. All agree otherwise with the original description and with Bocourt's figure (1873, Miss. Sci. Mex., pl. 14, fig. 5), and seem unquestionably to represent but a single species.

To provide an objective means of demonstrating variability, the tail was measured, in the six specimens available with intact tails, at a point opposite the heel as the hind leg was held adpressed to the tail. In the four males, varying in snout-vent length from 63.5 to 67 mm., the depth of the tail at heel varied from 2.9 mm. to 5 mm., whereas the width varied only from 2.2 mm. to 2.8 mm. (correlated measurements: 5x2.8, 4.8x2.8, 3.7x2.8, 2.9x2.2). In the two females measuring 55 and 56 mm. snout to vent the tail at heel measured 2.8x2.3 and 2.8x2.4 mm. The variation in compression in males is rather astonishing, occurring as it does in specimens of approximately the same size. The smallest compression (2.9x2.2 mm.), as a matter of fact, occurs in one with a snout-vent measurement of 66 mm. In two smaller females the tail is broken anterior to the heel level, but in each it appears nearly round in cross section. The comparative material was from Madruga, Soledad and Loma de Cunagua (Camaguey), Cuba.

The specimens encountered by Willis were found in a bat cave in the town of Buenaventura, Oriente, where a large population of the anoles was discovered inhabiting the walls at a depth of 75 to 100 feet below the surface of the ground. None were found outside the cave.

The specimens were extremely wary, of gecko-like actions, and were of a strikingly pale, translucent appearance, with dark, brick-red cross-bars on the back. They obviously were adapted, to a certain degree, for cave life by reduction of pigment, much like other cavernicolous animals. Two specimens kept alive for several days showed no metachrotic ability whatsoever; the colors remained the same.

Despite the wariness of the lizards, sixty-five were captured and placed

together in a collecting bag. Upon return to headquarters examination of the bag revealed a bloody and mangled mass in which only two specimens remained intact and were preserved.

In their astonishing pugnacity, their apparently exclusively cavernicolous habitat, and their loss of pigment and metachrotic ability, these lizards are, so far as we are aware, unique in the genus.

Apparently Buenaventura is the easternmost locality of record for this species, not previously noted from areas east of the province of Camaguey. Dr. Ernest Williams kindly advises that the Museum of Comparative Zoology possesses specimens that provide another record for Oriente, from Loma Tino Pupo, NW Holguin.

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Supplementary Notes on the Young of *Rana areolata*

By ARTHUR N. BRAGG

In the earlier observations (Bragg, 1954) it was noted that the jelly mass of *Rana areolata* becomes flattened during the development of the embryos and that the hatching larvae remain for an appreciable time upon this flat surface. The stage reached at hatching and the process by which hatching occurs were not observed and apparently remain wholly unknown for this species.

On February 20, 1954, I collected a small clutch of the eggs of *Rana areolata areolata* from a ditch beside Oklahoma Highway 21, six miles east of Idabel, McCurtain County, while on a collecting trip for the Oklahoma Biological Survey. These eggs were known to have been laid the night before. On the 21st they were placed in a large flat culture dish, covered with water from the pool and left to develop at room temperatures. On the afternoon of the 22nd, they were in various stages of gastrulation and 24 hours later most of them had closing neural tubes.

On the 24th at 4:00 P.M. (i.e., something over four and one-half days after the eggs had been laid) most of them had already hatched. This was unexpected in view of the long larval period noted in the paper cited (Bragg, 1954). Furthermore, there were other unexpected things about them. My notes, written with the animals before me, read: "They were outside the jellies but hanging tightly to them by a large ventral adhesive organ on each. The jellies had changed to the characteristic amber color, had sprawled some, floating; but they had not broken down at all. The bridges [between individual egg capsules as earlier described] were still strong. The embryos were the youngest (in stage of development) of any [amphibian] even seen to hatch. Many had no tail at all. They had absolutely no gills as yet. Some had emerged in a 'younger' condition than others. Many had hatched at too young a stage to need to be curved in the bubble of fluid [in which each lies before hatching]. Delayed ones, however, were curved in typical frog fashion.

"Each jelly from which a tadpole had emerged had a rather small, almost circular hole in one side, the opening just smaller than the great-

est diameter of a typical recently hatched tadpole. I saw no muscular movement in unhatched embryos and only *minor* and *slow* twitching of the tail bud in one or two of the larger ones already hatched. Ciliary movement was observed in the recently hatched tadpoles when they were shaken from the jelly. It was so weak that one could not see the animals 'crawl' on the bottom of a container, except with difficulty. It suggested the watching of the movement of the hour hand on a watch or small clock: one becomes conscious that a tadpole has changed position slightly without actually seeing it go."

Later in the spring, I observed another clutch, this time in the field, which had very young tadpoles on the jelly; and, still later, several others. In all of these cases some embryos had hatched at a younger development stage than others. From this it would seem that the process of hatching in *Rana areolata areolata* differs from that characteristic of other ranas, or at least of *Rana pipiens berlandieri* which I have often watched earlier. Presumably the secretion which dissolves the opening in the gelatinous envelopes develops very early and the embryos emerge by ciliary action only. It also seems likely that in nature the "lens effect" of the jellies mentioned in the former paper (Bragg, 1954) concentrates the heat from the sun's rays on the embryos at or near the top of the gelatinous mass, thus stimulating them to develop faster than those below them where the penetration of radiant energy is much less. This will not explain, however, the differential rates noted in the laboratory unless this influence had acted before I found them.

Another note is of interest. The alga often present in the jellies of *Rana areolata areolata* has been identified as *Oödinium amblystoma.* This is the plant commonly found in the egg jellies of some salamanders, notably *Ambystoma maculatum.* It is perhaps not surprising that this algal species should invade the egg jellies of another amphibian species but it is somewhat interesting to note that it has never been found in the egg masses of other Salientia or Caudata which breed at the same time and place as *Rana areolata.* Eggs of the following have been found abundantly in pools with those of *Rana areolata areolata: Rana pipiens berlandieri, Pseudacris nigrita feriarum,* and *Ambystoma texanum.* There was no evidence that the alga ever invaded the jellies in these species, but algae have been observed in one mass of egg-jelly of *Pseudacris n. triseriata.* See Gilbert (1942, 1944) for further notes on this or similar alga.

I am indebted to William C. Vinyard for the identification of the alga.

LITERATURE CITED

Bragg, Arthur N.
1954. A study of *Rana areolata* in Oklahoma. The Wasmann Journal of Biology II: 273-318.

Gilbert, Perry W.
1942. Observations on *Ambystoma maculatum* with especial reference to the green algae found within the egg envelopes. Ecology 23: 215-227.
1944. The alga-egg relationship in *Ambystoma maculata,* a case symbiosis. Ecology 25: 366-369.

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Analysis of the Herpetofauna of Baja California, Mexico. III.

NEW AND REVIVED REPTILIAN SUBSPECIES OF ISLA DE SAN ESTEBAN, GULF OF CALIFORNIA, SONORA, MEXICO, WITH NOTES ON OTHER SATELLITE ISLANDS OF ISLA TIBURON

By CHARLES H. LOWE, JR., and KENNETH S. NORRIS

Recent collection and study of fresh material of reptilian populations on Isla de San Estéban, Sonora, Mexico, indicates the occurrence of four endemic subspecies of reptiles in addition to the two recognized at present on this island. Two of these have been previously described (one as a species) and subsequently synonymized, and two are currently undescribed. There has been adequate recent study of only two reptiles occurring on this island, viz., *Sauromalus varius* (see Shaw, 1945), and *Crotalus molossus estebanensis* (see Klauber, 1949).

Three reptiles have been reported from Isla San Estéban in addition to the four treated herein. These are *Phyllodactylus tuberculosus homolepidurus* Smith, *Sauromalus varius* Dickerson, and *Crotalus molossus estebanensis* Klauber.

The gecko, *P. t. homolepidurus* is known from one specimen. The population is only tentatively assigned to the mainland group. As such it is the only land reptile of this island not currently known to be either a distinct endemic subspecies or species.

The unique chuckwalla, *S. varius*, has always been considered a distinct species and this seems to be the proper allocation.

The rattlesnake, *C. m. estebanensis*, is a well differentiated dwarf race which is endemic to San Estéban.

Comparative material, much of which has been collected by us, has been representative of populations throughout the peninsula of Baja California, on the mainland of Sonora, and of other islands in the Gulf of California. Materials have been studied that are deposited in the California Academy of Sciences, University of California Museum of Vertebrate Zoology, University of Arizona Department of Zoology, the collection of L. M. Klauber, and the collection of the authors.

Ctenosaura hemilopha conspicuosa Dickerson 1919 [*comb. nov.*]

The trivial name is particularly apt. We have collected series of this species on both the peninsula of Baja California and the mainland of Sonora, as well as on Isla San Estéban. Were this form as highly distinctive in other morphological characteristics as it is in color and pattern, it would be at least defensible to recognize it as a distinct species.

Dickerson (1919) was of the opinion that *conspicuosa* was a particularly large form. It has not been possible to substantiate significant differences in either size or proportions.

The color and pattern of this race is striking, particularly that of the males. While the females vary in the same general way, the racial differences are not so pronounced. On all surfaces of the males there is sharp

contrast of black and white. The darker, brown and brownish, ground colors of the upper surfaces of the head and body of *h. hemilopha* are lacking. Where areas are not solid black, they are dotted or spotted with black or blackish brown on white or whitish tinged with olive, faint green, or light gray. A black spotting and barring of the dorsal surface of the head and neck is pronounced. Conspicuously well developed narrow white crossbands occur on the legs, feet, and toes. There are 7 or 8 dark blackish or brown bands toward the tip of the tail, separated by narrower light-colored crossbands. An intricately reticulated black and white pattern occurs on the hind legs, rump, and base of tail, and is especially notable. Everywhere there is marked color contrast and patterning distinct from *C. hemilopha* of both Sonora and Baja California.

While significant differences in other characteristics are likely to be found upon detailed statistical analysis of large series, the outstanding distinctness in color pattern remains the most conspicuous characteristic of this subspecies.

Ctenosaura hemilopha conspicuosa is distinctive in 100% of its individuals and is obviously without actual gene exchange with other populations. Potential gene exchange with other populations of *C. hemilopha* is inferred. A *diagnosis* follows: A well marked population of *Ctenosaura hemilopha* differing in color and pattern and distinguished in adult males by (1) sharply contrasting colors consisting predominantly of intense black, on a ground color of white tinged with olive, green, or faint gray; (2) absence of brown colors on the head and body; (3) a sharply contrasting and intricate network of black and white positioned as distinct bands on the hind legs, rump, and base of tail; (4) distinct, narrow, white transverse lines on the front legs, four feet, and all toes; (5) black spotting and barring on the white dorsal surfaces of the head and neck: (6) the posterior half of body with numerous small black spots on a white to whitish ground color; and (7) 7 to 8 dark blackish or brown bands toward the tip of the tail separated by narrow gray bands.

Relative to the treatment of the species *C. hemilopha* it is proper to point out that either one should recognize one widespread and variable monotypic form, *Ctenosaura hemilopha,* or recognize a polytypic species with four subspecies of varying degrees of differentiation. The most distinct of these allopatric variants is *C. h. conspicuosa,* treated herein. Mainly on the basis of fresh materials collected by us in Baja California and Sonora, it is our opinion that four subspecies should be recognized, primarily on the basis of highly significant differences in color pattern; these are as follows:

Ctenosaura hemilopha hemilopha Cope
Distribution: Sonora (including San Pedro Nolasco Island), northern Sinaloa, and southwestern Chihuahua, Mexico.

Ctenosaura hemilopha conspicuosa Dickerson
Distribution: San Estéban Island, Sonora, Mexico.

Ctenosaura hemilopha insulana Dickerson
Distribution: Cerralvo Island, Baja California, Mexico.

Ctenosaura hemilopha interrupta Bocourt
Distribution: Southern Baja California (peninsula), Mexico.

*Uta stansburiana klauberi** subsp. nov.

The description of this subspecies is based upon a series of 33 individuals; 5 males and 2 females in the collection of L. M. Klauber, and 16 males and 10 females in the collection of the authors. The hypodigm is relatively uniform and shows considerably less variation than that of local populations occupying the same-sized areas on the mainland of Sonora and the peninsula of Baja California. It is found on no other island and is quite distinct from the population on the closely adjacent Isla Tiburón.

Holotype.—No. 6642 in the collection of Laurence M. Klauber, San Diego, California. Collected January 11, 1932, on San Estéban Island, Gulf of California, Sonora, Mexico, by J. R. Pemberton.

Diagnosis.—A subspecies of *Uta stansburiana* distinguished by (1) moderately large, discrete, and orderly arranged bright blue spots on the dorsal surface of the body, numbering 12-18 (15.9) on the midline from occiput to rump, 4-9 (6.4) transversely at midbody, and engaging up to 10 or more scales of wholly or partly blue color; (2) males and females with similar (rather than sharply dissimilar as in other forms of the species) pattern; (3) the dorsal surfaces of either sex without light body stripes, prominent brown spots, or bright tail chevrons; (4) large and light colored spots and bars on the lateral surfaces of the body; (5) 71-80 (75.3) relatively large middorsal scales in a row from ociput to rump; and (6) a single incurved row of postrostral scales.

Description of holotype (*well preserved in alcohol*).—Adult male, snout-vent length, 48.1 mm., tail length, 83.2 mm.; right hind leg, 32.3 to tip of fourth toe exclusive of nail. Transverse scale rows (measured on midline from occiput to rump) number 75; scale rows around base of tail directly posterior to vent, 22; 2 enlarged postanal scales; femoral pores, 15-14.

A single curved row of postrostral scales with rostral extending posteriorly on middorsal line; internasals as long as the median frontonasal; median frontonasal wider than the lateral frontonasals; prefrontals divided on the midline by a small scale; frontal divided; a curved row of 6 frontoparietals; 4 enlarged supraoculars; ear opening overlapped by 3 enlarged scales. The scales on the dorsal surface of the body increase in size posteriorly from the small and unkeeled granules of the neck region to the large and keeled imbricate scales of the rump.

A total of 16 bright blue spots occurs on the midline from occiput to rump; 7 blue spots, as counted transversely, occur on the dorsal surface at midbody. Blue spots constitute the only patterning in contrast to the uniform brownish ground color of the dorsal surfaces. Anteriorly the blue spots involve as many as 10 or more of the small scales; posteriorly the spots involve 3-5 scales which are respectably larged-sized. The numerous lateral spots are cream to light blue (in preservation), larger than those on the dorsal surface, and are occasionally in the form of thin vertical bars. The throat is dark blue. The chin is with distinct light spots increasing to bars laterally.

* Named in honor of Dr. Laurence M. Klauber, Consulting Curator of Reptiles in the Zoological Society of San Diego, San Diego, California.

The following color notes from a live adult male were recorded in the field: The spots on the dorsum of the body and tail are bright greenish-blue, and are a lighter, faint blue, on the head and neck; there is no other spotting on the dorsal surfaces. The ground color is dark brown on the middorsum of the body and tail. The side-blotch is large and intensely black, and without a border of lighter color. The sides of the body are bright orange and with a sharp line of demarcation on the dorsolateral surface between the dark brown of the back and the bright orange of the sides. A brown reticulum occurs on the sides, forming orange spots outlined with brown. The front legs are banded with orange and the hind legs and thighs are spotted with yellowish-orange.

The ground color changes ventrolaterally to very faint orange at the midventer. The chin is bright orange, but less bright than the orange chin of the female, and with gray marks along the outer edge. The ventral surfaces of the legs and tail are whitish to faint gray.

Material.—In addition to the holotype, 32 paratypes studied are as follows: L.M.K. Nos. 3968-71, 6640-41; C.H.L. Nos. 6300-6310, 6331-6346.

Comparisons.—U. s. klauberi is not a large *Uta*; large males reach approximately 51 mm. snout to vent; the largest available in the present study is a male measuring 51.0 mm.

U. s. klauberi appears closely related to, but distinct from, *U. s. taylori* of the San Carlos Bay area northwest of Guaymas, Sonora. We feel that *s. klauberi* and *s. taylori* are subspecies of *Uta stansburiana* and that they are not different species. In this opinion we disagree with the emphatic statement by Smith and Taylor (1950:150) that "possibility of intergradation between *Uta taylori* and *Uta stansburiana,* as recently suggested is too remote to consider. *Uta stansburiana* extends throughout the known range of *taylori.*" While sympatry is implied by Smith and Taylor, there remains no evidence for this. *U. s. taylori* and *U. s. stejnegeri* are allopatric, with *s. taylori* more or less surrounded by *s. stejnegeri.* The situation appears analogous to that of the relictual *Ensatina eschscholtzi picta* and *Ensatina eschscholtzi oregonensis* on the coast of extreme northwestern California and adjacent Oregon (see Stebbins, 1949).

Cnemidophorus tigris estebanensis Dickerson 1919 [*comb. nov.*]

Good series of this dwarfed whiptail are available. It is conspicuously and significantly differentiated in body size and in color pattern from *C. t. aethiops.* The largest specimen measures 83 mm. snout to vent. The approximate mean snout-vent length of large adults is 75 mm. as compared to 95 mm. for both the Isla Tiburón and adjacent Sonoran mainland populations of *C. tigris.* While differing in body size, proportions have tended to remain the same. For example, the extremely long tails of the populations on San Estéban, Tiburón, and the adjacent mainland of Sonora, all similarly exceed the snout--vent length by approximately 3.0 times.

The dorsal pattern of adults is progressively obscured posteriad on the back. The black dorsal markings are reduced or absent on the rump with the brown ground color concomitantly assuming greater local prominence. Black spots on the head are reduced in number or are absent, as compared

to *C. t. aethiops*. The intense black of the ventral surfaces of the chin, chest, and tail, which is also characteristic of the males of the Tiburón and mainland populations, is reduced in both intensity and distribution. The pattern on the sides consists of numerous small light colored spots on a dark background, as in the young of the Tiburón *tigris*, rather than of bold black transverse bars and spots as in the adults of the Tiburón animals. The young of *t. estebanensis* are very similar to other populations in aspects of color pattern with a progressive divergence occurring during ontogeny. The black element of the dorsal pattern is more finely reticulate rather than of large and bold black blotches. The conspicuous black spots on the upper surfaces of the tail of Tiburón and mainland animals are lacking. In all of these allopatric populations, however, the regenerated tail is black to blackish on all surfaces. This fact, as well as the facts that the young of all of them are very similar and the adults differ only in degree, point to the close relationship with common ancestry, and conspecificity of all of them.

Cnemidophorus tigris estebanensis is another significantly differentiated reptilian subspecies which is distinct in 100% of the individuals, on Isla San Estéban, and in the opinion of the authors is potentially interfertile with the populations of *Cnemidophorus tigris* on Isla Tiburón and the adjacent mainland of Sonora. A *diagnosis* follows: a dwarfed subspecies of *Cnemidophorus tigris* distinguished in adults by (1) a snout-vent length not exceeding approximately 85 mm.; (2) a relatively long tail exceeding the snout-vent length by approximately 3.0 times; (3) intensity of dorsal pattern reduced posteriorly; (4) reduction in intensity and distribution of the black coloring of the chin, chest, and tail venter; (5) pattern of sides consisting of small rounded light colored spots on a dark background; (6) lack of bold dark spots on the upper surfaces of the tail; (7) reduction or absence of black spots on the dorsal surface of the head; and (8) regenerated tail black to blackish on virtually all surfaces.

*Masticophis bilineatus slevini** subsp. nov.

The description of this subspecies is based upon a type series of 3 individuals. They are relatively uniform in characteristics. Among its several differences, the population is apparently dwarfed, which conclusion can only be fully tested by additional material. The only other snake on the island is a dwarfed rattlesnake (*Crotalus molossus estebanensis* Klauber). Comparative material has been available from Arizona and Sonora, including specimens from the latitude of Hermosillo on the mainland of Sonora east of Isla San Estéban. This subspecies of racer is most similar to *M. b. lineolatus* Hensley described from southern Arizona.

Holotype.—Number 3826 in the collection of Laurence M. Klauber, San Diego, California. Collected April 18, 1930, on San Estéban Island, Gulf of California, Sonora, Mexico, by Mrs. Griffing Bancroft.

Diagnosis.—A dwarfed form of *Masticophis bilineatus* distinguished by (1) a snout-vent length of less than approximately 900 mm.; (2)

* Named in honor of Mr. Joseph R. Slevin, Curator of Amphibians and Reptiles in the California Academy of Sciences, San Francisco, California.

dorsolateral light line obscured beyond ventral 100; (3) two ventrolateral dark stripes which are fused anterior to a point beyond ventral 50; (4) subcaudals without melanic stippling on midventral surface, and ventrals largely without stippling; (5) a midventral row of prominent dark spots extending from chin to not beyond ventral 40; (6) posterior chin shields relatively elongated, with length of longest going 2.01 (1.92-2.08) times into distance from tip of mental to posterior tip of longest posterior chin shield.

Description of holotype (*well preserved in alcohol*).—Adult female; snout-vent length, 833 mm.; tail length, 373 mm.; posterior chin shield (right) length, 9.6 mm.; anterior chin shield (left) length, 6.2 mm.; length of longest posterior chin shield going 1.92 times into distance from anterior tip of mental to posterior tip of longest posterior chin shield.

Scale rows 17-15-13; ventrals 204; subcaudals 132; supralabials 8-8; infralabials 10-10; preoculars 2-2, upper enlarged, lower greatly reduced in size and in contact with the 3rd and 4th supralabials; postoculars 2-2; loreals 1-1; internasals 2; prefrontals 2; nasals divided.

A large light spot in the upper preocular, loreal, and nasals; a less prominent spot in each of the postoculars. Infralabials with scattered black spots on lower edges; a thin black broken line on upper edges of infralabials and tip of mental. Supralabials with a thin black line along lower edges, adjacent to that along the upper edges of the infralabials; an irregular black line extending from rostral across upper edges of supralabials to corner of mouth and more or less continuous posteriorly joining the lateral black stripe.

Dorsal colors have changed somewhat in preservation (colors for a living specimen [C.H.L. No. 6319] are given below). Ventral ground color cream to yellow and with bold black spotting on chin and throat. The black spotting extends posteriorly as a mid-ventral row of black to brown spots, one on each ventral scale, to ventral 33. Ventrals not stippled with melanin except at very lateral-most edges. The ventral surface proper of the caudal scales is totally without melanic pigmentation.

The dark and light stripes from the dorsolateral to the ventrolateral surfaces are as in *M. b. lineolatus* Hensley (1950) with major differences as follows: The first and second ventrolateral (= sublateral) black stripes are fused as far posteriorly as ventral ca. 60; the dorsolateral light line fades out beyond ventral ca. 110.

Variation.—Paratype L.M.K. 41571 is a female measuring 751 mm. snout to vent; tail, 343 mm.; posterior chin shield (right), 7.7; length of right posterior chin shield goes 2.04 times into distance from anterior tip of mental to posterior tip of the chin shield. Scale rows, 18-16-13; ventrals, 203; subcaudals, 133; supralabials, 8-8; infralabials, 9-10.

The midventral row of black to brown spots extends posterior to ventral 38; the fused ventrolateral dark stripes extend to ventral ca. 85; the dorsolateral light lines fade out beyond ventral ca. 115. There is a lack of stippling on the subcaudal surface and virtually none on the ventral surface.

Paratype C.H.L. 6319 is a male measuring 869 mm. snout to vent; tail, 302 mm., posterior chin shield (left), 8.7 mm.; length of left pos-

terior chin shield goes 2.08 times into distance from anterior tip of mental to posterior tip of the chin shield. Scale rows, 17-17-13; ventrals, 210; subcaudals, 140; supralabials, 9 - 8; infralabials, 9 - 9.

The midventral row of black to brown spots extends to ventral 37; the fused ventrolateral dark stripes extend to ventral ca. 66; the dorsolateral light line fades out beyond ventral ca. 117. Again there is a virtually complete lack of the brownish or grayish stippling on the ventral and subcaudal surfaces, one of the most readily perceived quantitative differences of this race from other populations.

Colors of this specimen (C.H.L. 6319) when alive, as recorded on Isla San Estéban, are as follows: The lateral stripes on the neck are black and white, and gradually become brown and yellow posteriorly before disappearing. The ground color of the upper surfaces of the posterior part of body and tail is orange-brown; that of the anterior part of body, head (posterior part), and neck, is gray. The anterior portion of the top of the head, from the supraoculars forward, is brownish-orange, grading smoothly into the posterior gray.

The belly is immaculate yellow, as on the ventral surface of the tail, and gradually lightens anteriorly becoming white on the neck and chin. The chin marks are black; the ventral spots on the neck are blackish-brown lightening gradually to gray before finally disappearing.

The iris is an orange ring with a brownish outer border.

Comparisons.—Masticophis b. slevini is very closely related to *M. b. lineolatus,* both of which differ from *M. b. bilineatus* in color pattern. In being dwarfed, *M. b. slevini* appears to be divergent from both of the others in total body size. At first, the closer relationship to *b. lineolatus* than to *b. bilineatus* may seem odd in so much as *b. lineolatus* apparently occurs at such greater distance, in southern Arizona. However, additional disjunctive populations closely related to *b. lineolatus* should be sought in extreme western Sonora between the Sierra Cucabi near Sonoyta and the Sierra Seri opposite Isla Tuburón.

OTHER ISLANDS

Two reptiles previously thought to occur only on Isla San Estéban have recently been taken by us on other satellite islands of Isla Tiburón.

Two individuals of *Ctenosaura hemilopha conspicuosa* were collected and two more were seen (including a juvenile) on Isla Lobos.[1] This is a tiny and densely cactus-covered rock-like island positioned between Isla Tiburón and Isla Turners, and is approximately 0.3 mile off the southwestern coast of Tiburón.

Two individuals of *Sauromalus varius* were collected on Isla Pelicano (also called Isla Alcatraz), in Bahia Kino, due west of the southern part of Isla Tiburón.

Both of these newly-found established populations of lizards probably reached these islands by transport by man or by birds. The Seri Indians and some Mexicans eat both of these lizards. See Shaw's (1946:254) report of the transport of large chuckwallas *(Sauromalus hispidus)* by

[1] Tamayo (1949:571) gives the name as "Isla Lobos," and is followed here. This island is also called Isla Cholludo by Mexicans living at Kino, a fishing village at Bahia Kino on the adjacent mainland of Sonora opposite the island.

ospreys and by man in the Gulf of California and on the peninsula of Baja California.

No species of reptiles have been previously reported as occurring on either of these islands. In addition to *C. h. conspicuosa* taken on Isla Lobos, what appeared to be an adult of *S. varius* was observed to enter a hole in a rock cliff on this island, as reported by Mr. Richard S. Felger, a member of the expedition who had earlier assisted in the collection of a series of *S. varius* on Isla San Estéban.

In addition to the *S. varius* taken on Isla Pelicano, a series of *Uta stansburiana stejnegeri* was also obtained on this island.

LITERATURE CITED

Dickerson, M. C.
1919. Diagnosis of twenty-three new species and a new genus of lizards from Lower California. Bull. Amer. Mus. Nat. Hist., 41:461-477.

Hensley, M. M.
1950. Results of a herpetological reconnaissance in extreme southwestern Arizona and adjacent Sonora, with a description of a new subspecies of the Sonoran whipsnake, *Masticophis bilineatus*. Trans. Kansas Acad. Sci., 53(2):270-288.

Klauber, L. M.
1949. Some new and revived subspecies of rattlesnakes. Trans. San Diego Soc. Nat. Hist., 11(6):61-116.

Shaw, C. E.
1945. The chuckwallas, genus *Sauromalus*. Trans. San Diego Soc. Nat. Hist., 10(15):269-306.
1946. A new locality for the spiny chuckwalla, *Sauromalus hispidus*. Copeia, No. 4:254.

Tamayo, J. L.
1949. Geográfica general de Mexico. Tomo 1. Geográfica física. Talleres Gráficos de la Nación, Mexico.

Smith, H. M. and E. H. Taylor
1950. An annotated checklist and key to the reptiles of Mexico, exclusive of the snakes. Bull. U. S. Nat. Mus., 199:1-253.

Stebbins, R. C.
1949. Speciation in salamanders of the plethodontid genus *Ensatina*. Univ. Calif. Publ. Zool., 48(6):377:526.

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A New Subspecies of *Urosaurus graciosus* Hallowell with a Discussion of Relationships Within and of the Genus *Urosaurus*

By CHARLES H. LOWE, JR.

While the Long-tailed Brush Lizard *(Urosaurus graciosus)* has an extensive range across southern Arizona, to eastern Pima County, until

recently few specimens have been available from east of Yuma County. With additional fresh material at hand it is apparent that the populations of the general Arizona Upland Desert area represent a subspecies distinct from the populations of the Lower Colorado Desert proper, to the west.

The following abbreviations are used: C.A.S., Chicago Academy of Sciences; M.V.Z., Museum of Vertebrate Zoology, Berkeley; U.I.M.N.H., University of Illinois Museum of Natural History; F.A.S., F. A. Shannon; and C.H.L., C. H. Lowe, Jr.

Urosaurus graciosus shannoni[1] subsp. nov.

Holotype.—Number 5714 in the collection of Frederick A. Shannon, Wickenburg, Alizona. Collected August 3, 1954, on the east bank of the Hassayampa River, at 2 miles west of Morristown, Maricopa County, Arizona, by Richard W. Abbuhl and Gerald O. Gates. Preserved in alcohol August 4, 1954.

Paratypes.—F.A.S. Nos. 5709-5712, 5890-5895; C.H.L. Nos. 6429-6432; U.I.M.N.H. No. 35908, all from the type locality.

Diagnosis.—Distinguished in males by a highly contrasting pattern of black and gray colors on upper surfaces with (1) 6 to 7 bold black dorsolateral transverse bars often connected with paired black blotches on dorsum; (2) 6 to 8 black or blackish lateral oblique bars, which may form lazy chevrons; (3) 5 to 6 bold black crossbands on the forelegs; (4) the dorsal surface of the tail with 20 to 25 paired dark spots, with the last ca. 10 fused; (5) a bold black collar on the posterior portion of the neck that is incomplete middorsally, reaches laterally to the shoulder, and continues onto the upper arm; (6) two blue belly patches separated by 2 scale rows. Two, or three, middorsal scale rows across the rump notably reduced in size. Dorsal transverse scale rows, 62.8 ± 1.1 (59 – 72) from occiput to rump. Ratio of tail length over snout-vent length, 2.3 (2.21 – 2.45) in males.

Description of holotype.—Adult male, with a snout-vent length of 59.2 mm.; regenerated tail, 71.0 mm.; right hind leg, 34.2 mm. to base of fourth toenail. Femoral pores, 10 – 11.

Transverse scale rows from occiput to rump, 67. There are two rows of keeled scales on the middorsal line that are smaller in size than the adjacent and more enlarged paravertebral rows. These two middorsal longitudinal rows of smaller scales extend for the greater length of the body and increase to three rows of smaller sized scales over the rump. Thus across the rump there is the same condition, on the dorsal surface, of notably unequal-sized scales as is found at midbody (this differs from *g. graciosus* which usually has all middorsal scales across the rump of approximately equal size). Head scalation essentially as in *U. g. graciosus.*

The dorsal pattern is of highly contrasting blacks and grays. The ground color of the upper surfaces of the body and tail are light gray, at 35° C, darkening to darker grays at lower body temperatures. The head is light tan. The upper surfaces of the head are punctated and streaked with brown and black. The primary pattern of the back consists of eight

[1] Named in honor of Dr. Frederick A. Shannon of Wickenburg, Arizona.

pairs of black blotches most of which are confluent with bold black dorsolateral transverse bars. The sides have oblique black and blackish transverse bars extending onto the ventrolateral surface to the edge of the blue belly patches. The hind legs are boldly marked with blackish-brown. Front legs, feet, and toes are boldly and consistently marked, with 5 to 6 black transverse bands on the legs, and black spots on the feet and toes. The distal portion of the tail is regenerated, and is uniform gray. The proximal part of the tail is normal, with small blackish spots on the upper surfaces and small gray marks or streaks on the ventral surfaces.

The belly patches are light blue; each contains a few scattered small light spots and small blackish spots anteriorly. The two blue patches are separated by a distance equal to two rows of white scales. The chest and gular fold area is immaculate white. The chin and throat are light yellow.

Variation.—The holotype, a male, is the largest individual in the hypodigm (N = 16) and measures 59.2 mm. snout to vent. The largest female measures 52.9 mm. snout to vent. The ratio of tail to snout-vent length in males (juv. to ad.) is 2.33 (2.21 – 2.45); in adult females, 2.22 (2.16 – 2.24). The mean, standard error, and range for the dorsal scale rows is 62.8 ± 1.1 (59 – 72). There are either 2 or 3 middorsal rows of smaller scales across the rump, and 2 at midbody.

The dorsal color pattern is one of highly contrasting black and gray colors in males and brown and gray in famales. There is variation in the amount of color contrast at different body temperatures, in the sexes, and in different individuals.

The females are notably less boldly marked on all surfaces than are the males. They are without blue belly patches and there is only a trace of light yellow on the chin. There is light brown and/or gray spotting and streaking on the ventrum as in most males (the holotype is an exception in virtually lacking this). The black dorsal and lateral transverse bars so characteristic of the males of this race are virtually absent in the females. The characteristic dark bands on the front legs and dark spots on the tail are conspicuously and consistently present also in the females, though they are of lighter colors.

In the males the contrast of the dorsal color pattern varies from almost that of black on white, to blackish on gray. In all of them, the marks are conspicuous and there is especially bold patterning on the back, sides, legs, and tail. By comparison, males of *U. g. graciosus* in the Lower Colorado Desert of California are virtually patternless. The belly patches of the males vary individually from greenish-blue to light bluish-green, and they vary also with body temperature. The color of the chin and throat varies individually from light yellow to deep orange. In some adult males the tail is distinctly tan on the upper surfaces in contrast to the gray of the body.

Geographic and ecologic distribution.—*U. g. shannoni* is known from Yavapai, Maricopa, Pinal, and Pima Counties, in southern Arizona. The following locality records are based partly upon records in the literature; all are in Arizona (Fig. 1, map). The records of Burt and Burt (1929) for the area Casa Grande — Maricopa are included. While they are not verifiable as applying to this species they are, nevertheless, acceptable

on both ecologic and geographic grounds. Moreover, no other species of *Urosaurus* has been taken there.

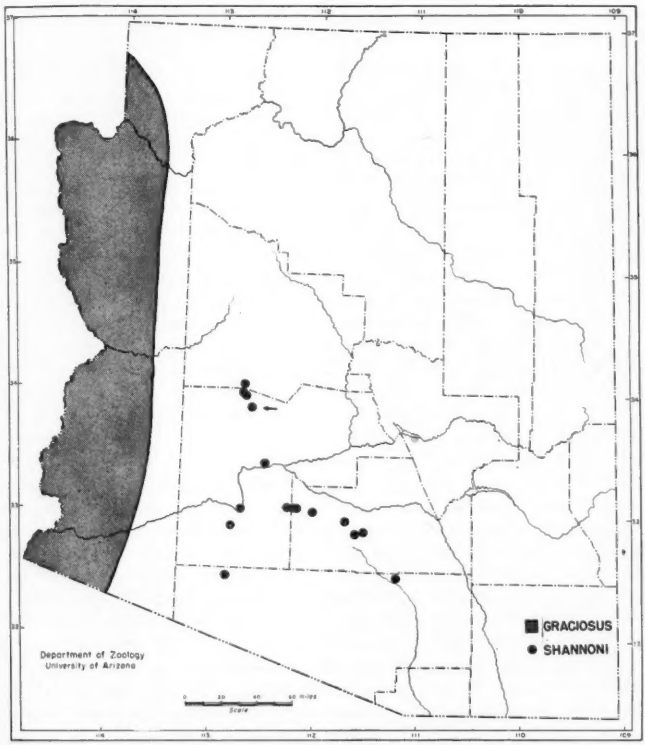

Fig. 1. Distribution of the subspecies of *Urosaurus graciosus* in Arizona. The range of *U. g. graciosus* is as given by Smith (1946: 495) for the species *U. graciosus,* in Arizona. The arrow points to the type locality of *U. g. shannoni.*

Yavapai County: Box Canyon, Hassayampa River, 5 miles north Wickenburg (C.A.S. Nos. 3076, 3113, 10217-10220). *Maricopa County:* 6 miles north Gila Bend; 6.9 miles west-south-west Gila Bend (Murray, 1953:112; M.V.Z., 4 specimens); 0.5 miles southeast Wickenburg (F.A.S. No. 1395); 2 miles southeast Wickenburg (F.A.S. No. 980); Hassayampa River, 2 miles west Morristown (U.I.M.N.H. No. 35908; F.A.S. Nos. 5709 - 5712, 5714 [holotype], 5890 - 5895; C.H.L. Nos. 6429 - 6432); 26 miles northwest Phoenix, along h'w'y. 80 (F.A.S. No. 251); 13 miles west Maricopa (Burt and Burt, 1929). *Pinal County:* 8 miles south Coolidge (Murray, 1953:112; M.V.Z. No. 20530); and the

following of Burt and Burt (1929); 10 miles southeast Casa Grande; 2 miles northwest Casa Grande; 6 miles southeast Maricopa; 9 miles west Maricopa; and 10 miles west Maricopa. *Pima County:* 6 miles northeast Ajo (Gloyd, 1937:108); Marana, in the Avra Valley (C.A.S. No. 11224).

The species *U. graciosus* reaches its easternmost distributional limit in the Avra Valley of eastern Pima County, along the western side of the Tucson Mountains. It is a member of a characteristic assemblage of the Lower Colorado Desert herpetofauna which assemblage reaches its eastern distributional limit in this area. This natural community includes *Dipsosaurus dorsalis, Sauromalus obesus, Urosaurus graciosus, Phrynosoma platyrhinos, Chionactis occipitalis,* and *Crotalus cerastes.* It is assumed that *U. g. graciosus* and *U. g. shannoni* intergrade in western Pima and Maricopa Counties and in eastern Yuma County, Arizona.

Apparently the only published records for *Urosaurus graciosus* east of Yuma County, Arizona, have been those of Burt and Burt (1929) for the Casa Grande — Maricopa area of Pinal County, and of Gloyd (1937) for 6 miles northeast of Ajo, Pima County. This more eastern area is not designated as in the range of this species by Smith (1946:495); see Fig. 1, map. Recently Murray (1953) published the record for eight miles south of Coolidge, Pinal County, which was considered by him to represent an eastward range extension of 150 miles for this species. Coolidge is approximately 75 miles east of Ajo and 20 miles east of Casa Grande.

There are relatively few localities from which *g. shannoni* is known with certainty. Apparently all have been discovered by chance and it is probably a far more abundant species in south-central Arizona than previously supposed. Its distribution here is spotty, and individuals are not easily seen in the plant niche where it occurs. This has importantly contributed to the recent difficulty in locating new populations in the eastern part of the range of the species.

U. g. shannoni has been taken almost exclusively on the trunks and branches of larger desert trees, viz., Mesquite *(Prosopis juliflora),* Cat Claw *(Acacia greggi),* and occasionally Paloverde *(Cercidium microphyllum).* In this respect it has been found to occur under immediate ecological conditions that are different from those common for *g. graciosus;* the latter is usually found upon small and large desert shrubs. The darker *g. shannoni* is well adapted to darker bark colors.

The habitat niche of *U. g. shannoni* in the Hassayampa River area near Wickenburg, Arizona, is not unlike that of *U. ornatus.* And the two, while occasionally in complete ecologic microgeographic sympatric contact, are usually found segregated into local breeding populations in which the other is completely absent. This is indicative of competition in what appears to be identical spatial or habitat niches, and offers an interesting ecological problem.

Relationship of Urosaurus graciosus and *U. ornatus.*—The sympatric distribution of *U. graciosus shannoni* and *U. ornatus linearis (= schotti auct.)* in the Hassayampa River drainage of Arizona resolves the problem as to the distinctness of these two species. Smith (1946) suggested the possibility of conspecificity of the two subsequent to Mittleman's (1942)

incorrect placement of them in single species. The two species have been recently collected in the same Mesquite-thicket in the Hassayampa drainage, at 2 miles southeast of Wickenburg, Maricopa County, Arizona. Both species are common in this river drainage, with *U. ornatus* the most abundant by a considerable margin.

The genus Urosaurus.—Notwithstanding the recent works of Schmidt (1953), Murray (1953), and Stebbins (1954), the genus *Urosaurus* Hallowell is maintained here, as distinct from *Uta* Baird and Girard. Lowe and Norris (ms.) have made a study of the relationships of *Petrosaurus, Streptosaurus, Urosaurus,* and *Uta,* and it is the conclusion of these authors that these groups represent three genera and two subgenera, as follows:

Petrosaurus Boulenger
  Petrosaurus Boulenger
  Streptosaurus Mittleman
Urosaurus Hallowell
Uta Baird and Girard

This system embodies the recognition of the ground-dwellers *(Uta),* plant-dwellers and climbers *(Urosaurus),* and the cliff-dwellers *(Petrosaurus),* as three polytypic natural evolutionary groups of respectable adaptive divergence in the summation of the structure, behavior, and ecology that is characteristic to each. These three life-forms have adaptively capitalized upon three distinctive ecological opportunities. They occupy three different generic niches. The three natural groups are recognized as genera on the basis of the total biological similarity of the comprised species, and not on the basis of any single "generic-character" differences. It may also be noted that they are not recognized for any important reasons intrinsic to Mittleman's (1942) work.

Morever, the genus *Petrosaurus* appears to belong in a section of the Iguanidae separate from *Crotaphytus* (sensu Smith, 1946) and from *Uta* (sensu Schmidt, 1953).

LITERATURE CITED

Gloyd. H. K.
1937. A herpetofaunal consideration of faunal areas in southern Arizona. Bull. Chicago Acad. Sci., 5 (5): 1-136.

Mittleman, M. B.
1942. A summary of the iguanid genus *Urosaurus.* Bull. Mus. Comp. Zool., 91: 103-181.

Murray, K.
1953. Notes on the taxonomy and distribution of the lizard species *Uta ornata* and *Uta graciosa.* Herpetologica, 9 (2): 110-112.

Schmidt. K. P.
1953. A checklist of North American amphibians and reptiles. 6th ed. The Chicago University Press.

Smith, H. M.
1946. Handbook of lizards. Comstock Publ. Co., New York.

Stebbins, R. C.
1954. Fieldbook of amphibians and reptiles of the western United States. McGraw-Hill Book Co., New York.

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Plethodon nettingi in Virginia *

By G. R. THUROW

Several specimens of a small *Plethodon* collected in Bedford County, Virginia (Chicago Natural History Museum 60512-18), are referable to *P. nettingi* Green. The lot was collected by Leslie Hubricht "near stake 320, Blue Ridge Parkway; Rich Mountain, 9 mi. S. of Black Rock Hill," September 10, 1949.

Another series of 33 *P. nettingi* (Carnegie Museum 19741) from Gaudineer Knob, Pocahontas Co., West Virginia, was compared with the Virginia specimens. Detailed measurements show that the proportions and growth rates are essentially the same in the two lots.

The costal groove counts in the Virginia specimens average high, four of the seven having 19 grooves on at least one side, but are within the reported range of variation (17-19).

The adpressed costal fold counts (excluding animals less than 25 mm. in body length) averaged 5.5 (range 4½-6) in the Virginia series and 4.8 (range 4-6) in the West Virginia series. This compares with 4.0 (range 3-5) given in the original description (Green, 1938), and the "5½-6" given by Bishop (1943). The Virginia animals are not considered to be significantly different in view of these varying counts, particularly since five of the six counted are quite large, and the specimens are slightly hardened and inflexible.

No consistent differences in mouth characters could be found. Most of the West Virginia *nettingi* examined have smaller, narrower tongues, but this contradicts its description by Bishop (1943), and it is dismissed as a probable preservation effect since the tongues of related species have been observed to shrink and change shape upon preservation.

Male sexual dimorphism is characteristically poorly developed in both samples. The premaxillary teeth are not enlarged and the mental gland is undeveloped. The snout appears slightly more swollen.

Hedonic glands are distinguished by Noble (1929, 1931) and others, but taxonomists in general have failed to describe their development in *Plethodon*. The writer first described these glands in *Plethodon glutinosus* (M.S. thesis, 1951). They are characteristic only in males, in the eastern small *Plethodon*, and occur mainly on the ventrum of the tail.

Ventral hedonic glands are more conspicuous in the Virginia specimens, but this is thought to be a seasonal difference in activity since the glands are swollen with secretion in this series and not in the other. The distribution of the glands seems to be more extensive in the Virginia material, extending along at least the proximal half of the tail, while the midpoint of the tail does not appear to be reached in the West Virginia series. This apparent difference may be local or seasonal variation.

A definite difference appears in the average pigmentation of the two series. The bellies of the Virginia specimens are immaculate black with no gaps (except at the joints and in the margin of the gular fold), unlike any of the CM series, or CNHM specimens 92804-5 from Cheat Bridge, Randolph Co., West Virginia. There are some gaps in the gular area (particularly in the two juveniles) and the cheeks and lower flanks of the

* Contribution No. 584 from the Zoological Laboratories of Indiana University.

Virginia material, but fewer and smaller than in most of the West Virginia specimens. Similarly, the extremely minute gaps of the dorsum appear less developed in the Virginia specimens. Although these animals evidently have a dorsal metallic flecking in life, the amount may be different in most *nettingi* from West Virginia.

The pigmentary differences of these samples generally fall within the range of variation given in Green's original description, in which belly flecking is mentioned only as a variation. Furthermore, a paratype (CNHM 92803) from Randolph County, West Virginia, also has a practically unflecked black ventrum and fairly conspicuous hedonic glands, quite like the Virginia material.

The fact that the locality from which these Virginia specimens were obtained is separated from the rest of the known range by the Great Valley, suggests the possibility of divergent insular populations. Examination and comparison of larger series and living material from the two states will be necessary before the possibility of subspeciation can be excluded.

On September 18, 1954, I revisited the collection site in an attempt to obtain live material. Extreme dryness prevailed, and the only *Plethodon* obtained were three *glutinosus* inside large logs, and two *cinereus* a few miles up the road in a mass of wet leaves below a spring.

Collectors may find it difficult to find this locality, since the old system of white wooden stakes has been replaced by cement mileposts, and many of the former are no longer visible. The old faded stake 320 is just north of milepost 92 and south of the intersection with Va. 43, west of Buchanan. The whole "Peaks of Otter" areas should be searched.

I wish to thank Mr. Clifford Pope, Mr. Robert Inger, and Mr. Hymen Marx for the loan of CNHM specimens and Mr. Neil Richmond for the loan of CM specimens.

LITERATURE CITED

Bishop, S. C.
1943. Handbook of salamanders. Ithaca: Comstock Publishing Co., pp. 1-155.

Green, N. B.
1938. A new salamander, *Plethodon nettingi*, from West Virginia. Ann. Carnegie Mus., 27: 295-9.

Noble, G. K.
1929. The relation of courtship to the secondary sexual characteristics of the two-lined salamander, *Eurycea bislineata*. Amer. Mus. Novit., No. 362.

Noble, G. K.
1931. The biology of the amphibia. McGraw-Hill Book Co., New York.

Thurow, G. R.
1951. Unpublished M.S. thesis, University of Chicago, Microfilm at Ann Arbor.

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ANOTHER RECORD for *CEMOPHORA COCCINEA* (BLUMENBACH) IN MARYLAND.—Judged on the basis of the number of specimens collected, the scarlet snake, *Cemophora coccinea* (Blumenbach), is the rarest of the snakes reported from Maryland, with the exception of the pine snake, *Pituophis melanoleucus melanoleucus* Daudin.

Fowler (1945, *Proc. Biol. Soc. Wash.*, vol. 58, pp. 89-90) summarizes the records available and notes that the scarlet snake has been reported from six localities in Maryland. The earliest record, according to Fowler, is that of Prof. A. Wyatt, who collected this snake from Baltimore. Another early record is a specimen collected at St. Margarets, Anne Arundel Co., in 1891. Subsequent records include Salisbury, Wicomico County; Brandywine and Lanham in Prince Georges County; St. Denis in Baltimore County; and Severn in Anne Arundel County.

McCauley (1945, *The Reptiles of Maryland and the District of Columbia*, pp. 101-102) makes no mention of the collection of Wyatt and rejects the records from St. Denis and Severn because of the valid objection that they may not have been correctly identified.

The purpose of this note is to add to the above mentioned records by reporting the collection of a single specimen of this snake from Mill Creek, Anne Arundel County, Maryland, on June 8, 1947. This specimen was collected by Dr. Phillip A. Butler of the U. S. Fish and Wildlife Service and is now No. 43 in the collection of the University of Maryland. The tail is two inches long, or 15.3 per cent of the total length.

Summarizing the records of *Cemophora coccinea* in Maryland, we find that a validly identified specimen has been collected in a total of six localities. All of these, with the exception of the Baltimore record of Wyatt in 1862 (Fowler, '45) are located in the Coastal Plain area. The other two records, one near St. Denis and one near Severn by Kelly, Davis, and Robertson (1936, *Snakes of Maryland*, p. 68) are rejected.

It should be noted also that the record from Salisbury apparently represents two different collections. Fowler ('45) bases his note on a specimen collected by J. P. Brown on April 5, 1923. This specimen was at one time, according to Fowler, University of Maryland No. 1. At present, it is no longer in existence at the University and was not in the University collection when it was reorganized by the author in 1943. The record of its original presence, however, was still carried in the files. On the other hand, the record of McCauley is based on a specimen of R. Conant, for which no date of collection is given. The statement of McCauley ('45, p. 101) that, "It has not been taken on the Eastern Shore," is apparently a typographical error, as Salisbury, Wicomico County, is located on the Eastern Shore of Maryland.—Robert A. Littleford, Dept. Zool., Univ. Maryland, College Park, Maryland.

The Natural History of the Hog-nosed Snakes, Genus *Heterodon*: A Review[1]

By RICHARD A. EDGREN

Interest in the ecology of various reptiles has increased recently, particularly as such studies contribute to other biological fields. Unfortunately much published information has been gathered uncritically, and is widely scattered through the literature. In an attempt to rectify these problems Fitch (1949) and Cagle (1953) have summarized what they believe should be included in life history studies. These reviews provide convenient forms for outlining facts regarding the life histories of reptiles. Even considering common species, available data fall far short of the ideals of Fitch and Cagle as is sharply demonstrated by the present review of the natural history of the hog-nosed snakes, genus *Heterodon*. Fitch's outline has been followed in this paper, although material of a biogeographic nature will be presented elsewhere.

THE EGG AND EMBRYO

Data on time of depositon, number and size of eggs of *H. platyrhinos* have been summarized in Table I. There may be a geographical influence on laying dates, as Logier (Ontario) and Breckenridge (Minnesota) report eggs laid in July, whereas in southern localities they are generally laid in June. August records involve captive snakes.

Length of the ellipsoid, off-white, thin-shelled, non-adherent eggs varies from about 20 to 39 mm., and width from about 12 to 30 mm. Clark (1952b) measured volumes of two clutches by displacement of water; one clutch varied from 2.0 to 3.0 cc., mean 2.6 cc., and the other 3.5 to 5.0, mean 4.25 cc. Clark also shows positive correlation coefficients between length and width measurements on *platyrhinos* in contradistinction to *Diadophis punctatus* and *Opheodrys vernalis* which Blanchard showed to be negatively correlated. Clark's data are not entirely convincing as biases resulting from the many large and small eggs in his clutches would shift coefficients in a postive direction. Clark has shown also that volume is more closely correlated with length or width than they are with each other; this is to be expected as volume is a function of length and width in any body. Thus the correlations and the conclusions based upon them would appear spurious.

Clutch size varies considerably; as few as four and as many as 61 eggs per clutch have been reported. Geographic variation in egg and clutch size is unknown.

Data on the eggs of *nasicus* are rare. Breckenridge (1944) recorded a Minnesota specimen with 9 eggs. The most extensive information on eggs of this species was published by Munro (1949b); a captive female laid 11 eggs on the night of 5-6 July, 1949. These eggs varied from 31.5-35.5 mm. in length and from 18.5-20.0 mm. in width at the time of laying; weights were from 6.1-6.8 grams.

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[1] The present paper is extracted in part from a dissertation submitted to the graduate school of Northwestern University in partial fulfilment of the requirements for the degree Doctor of Philosophy. I am indebted to Prof. Orlando Park who suggested the problem and who directed the study through to its completion.

TABLE I

Summary of available information on time of deposition, number and size of eggs of *Heterodon platyrhinos*

Date of Deposition	No. Eggs	Size Extremes[1]	Mean	Weight Extremes[2]	Mean	Authority
20-vii to 1-viii	15	26.3-32.3 x 12.8-18.3	29.0 x 17.1	2.7-6.2	4.9	Edgren
	25					Hay, 1892
	22					do
	27					do
	18					Guthrie, 1926
23-vi to 26-vi	10					Gloyd, 1932
June and later	22					Wright & Bishop, 1915
	30					
	42		30 x 21			do
19-vi	27	29-35 x 19-22	32 x 20			Conant, 1938a
1-vii	12	24-28 x 15-17	26 x 15.8			do
	7					do
As late as July	22					McCauley, 1945
	16					do
	18					do
	27		30 x 20			Hudson, 1942
12-vii	31					Logier, 1939
7-vii	12	27-36.5 x 18-21				Breckenridge, 194
	61					do
	39					do
7-vi	35					Cagle, 1942
26-vi	4					do
	19	20-24 x 13-16	21.8 x 14.6			Clark, 1952b
8-viii	22	25-30 x 16-21	27.0 x 18.1			do
6-vi to 7-vi	35	21-39 x 20-30	30.6 x 22.7			do

[1] all sizes in millimeters
[2] weights in grams

Information on the eggs of *simus* is practically nonexistant. Price and Carr (1943) report a clutc hof 6 laid 20-22 October by a captive Florida female. These eggs varied from 25-30 mm. in length and from 11-14 mm. in width; weight was 2.1-2.5 grams. During the present study 10

eggs were dissected from a *simus* (CNHM 35567, Thomasville, Thomas County, Georgia).

Few generalizations can be drawn from these data, although it seems probable that *simus* and *nasicus* may generally produce fewer eggs than *platyrhinos*. Egg size may also differ from species to species. Weights and measurements were taken, within 24 hours of deposition, on 11 eggs of a *platyrhinos* clutch, and Munro's (1949b) *nasicus* eggs were measured within a comparable period. With regard to these two clutches, *nasicus* eggs are significantly longer, wider, and heavier than *platyrhinos* eggs. The Price and Carr data may be questioned as October seems extremely late for egg-laying.

Size increases in eggs are poorly documented. Munro's eggs were carried through to hatching and periodic weights and measurements were taken. His last measurements were made about ten days before hatching, or after 45 days of incubation. Statistical comparison of the weights and measurements shows that length does not change significantly through this period, although both width and weight increase significantly. Should these relationships prove to be general for snake eggs, they will partially obviate the difficulties pointed out by Cagle (1953:41), and published length data will be of value despite lack of information relative to age or incubation conditions. Through this 45-day period weights increased about 50%, the greatest proportion of which took place during the first four weeks (43%). Only three *platyrhinos* eggs were weighed more than the initial time. Their increases were as follows:

Laying weight	7 days later	9 days later
5.1 g.	5.4 g.	
5.3	5.7	5.8 g.
3.0	3.1	

These data suggest a progressive increase during incubation.

Although embryological information on *Heterodon* is rare, Franklin (1945) studied the time of appearance of centers of ossification in the bones. He states that these centers appear somewhat earlier in *Heterodon platyrhinos* than in *Natrix taxispilota*, and that the hatchlings of *Heterodon* are more completely ossified than newly born *Natrix*. This retardation of developmental rate may be a general concomitant of ovoviviparity.

Several authors have reported incubation periods. Munro's *nasicus* eggs began hatching on 30 August, and the last snake emerged 4 September, an incubation period of 56 to 61 days. Records for *platyrhinos* were as follows: 31 days (Cagle, 1942), 57 days (McCauley, 1945), and 58-59 days (Gloyd, 1932). Nothing is known of the incubation period of *simus*.

Natural nests are unknown for *simus* and *nasicus*, and few observations have been published on *platyrhinos*. Breckenridge (1944) reported finding two eggs at a depth of about 6 inches in a gravel deposit, and Wright and Bishop (1915) describe clutches found at depths of four to five inches in sandy fields. Cagle (1942) found a clutch under a rock.

Possible brooding of the eggs was reported by Hahn (Noble and Mason, 1933), who found a female coiled around eggs in a cornfield, and Hay (1892) mentions a female that presumably attempted to defend

a nearby clutch. As such observations have not been repeated, or confirmed in the laboratory, it seems best to suspend judgment on maternal care until further data become available.

Surface (1906) suggests that *H. platyrhinos* may be ovoviviparous. He reports a specimen containing embryos about 6½ inches in length, enclosed in a transparent membrane. It is very difficult to reconcile this report with other available evidence.

THE YOUNG

Too few clutches have been carried through to hatching to permit any generalizations on mortality in the egg stage. Munro hatched 11 young *nasicus* from 11 eggs and nothing is known of the number of young in litters of *simus*. Gloyd (1932) hatched eight young from nine *platyrhinos* eggs; Cagle (1942) opened portions of clutches he had, but all eggs allowed to run full term hatched. McCauley (1945) quotes McClellan as hatching one young from 14 eggs. Under favorable conditions most of the eggs in a clutch may hatch, even in the field.

Sex ratios of litters are available only for Gloyd's clutch and one hatched by George P. Meade of Gramercy, Louisiana (Ca 10407-20). Gloyd's group contained 5 females and 3 males, and the Meade litter contained 9 females and 5 males. Neither ratio deviates significantly from a 1:1 ratio ($x^2 = .50$ and 1.14 respectively).

Munro (1949c) has described the hatching process in *nasicus*. The young snakes make longitudinal slits in the upper side of the eggs and then thrust their heads through the slits, enlarging them as they do so. Their heads come through the slits upside down, probably because the head must be inverted to bring the egg-tooth, on the under side of the rostral, against the inner side of the egg's upper surface. The snakes lay for some time with heads protruding and body coiled within the egg, and occasionally were seen to "writhe and squirm" inside the eggs. The heads were also retracted now and then and were likely to come out upside down. Sometimes the heads were worked around to right side up.

Hatching apparently takes a long time as Munro reports the shortest period from initial slit to complete emergence as about 30 hours for one individual and 40-60 hours for most of the 11. Most of the snakes emerged during the warmest part of the day, mid-afternoon, although 3 completed hatching late at night or in early morning. Crawling out of the egg required about an hour after the final "decision" was made. Most of the young lost parts of their initial sloughs while crawling from the eggs and shedding was completed within an hour or so of emergence.

Munro describes the egg-tooth as: ". . . a tiny, forward-pointing, white, conical thorn on a small grayish mass filling the lingual groove of the rostral scale. . . ." The tooth is lost within about an hour of emergence. Munro suggests that the egg-tooth is swallowed as he was unable to find the shed teeth, although he made a special effort to do so.

THE ADULT

Hibernation

Only one report on hibernation in *Heterodon* is in the literature. Neill

(1948) states that *platyrhinos* is the last reptile to go into hibernation. Hibernacula are individual and include areas "beneath rocks, stumps, or rubbish piles, in burrows in hard red clay soil, or even beneath slabs of tin on the open ground." Neill says it is semi-dormant when disclosed implying that *Heterodon* do not hibernate in the mammalian sense, but go into a state of cold-inactivation or pseudohibernation. In addition interpretations can be based upon information presented by Conant (1938b). *Heterodon platyrhinos* were obtained in Lucas County, Ohio, from April to October (one in October). This indicates that the species enters hibernacula during September and/or October, and leaves them in April, or as late as May. It seems probable that temperature is of paramount importance in inducing pseudohibernation, although other factors certainly are operative. Conant (1938b, fig. 1) presented a curve of mean monthly temperatures from Weather Bureau statistics. Such data may differ significantly from the micro-climates of the areas in which the snakes live; however, the graph shows that April temperatures increase through the same range as mid-September to early October temperatures decrease. During both periods mean temperatures vary between about 50 and 60 degrees Fahrenheit. This suggests that critical temperatures for induction of pseudohibernation in Lucas County *platyrhinos* lie between 50 and 60 degrees Fahrenheit.

The young seem less affected by low temperature than the adults as Neill (1948) states that young-of-the-year are found active as late as November or December.

Breeding

Data on the breeding habits of *Heterodon* are generally not available. Certain aspects of copulatory mechanics have been described from dissection of specimens preserved in coitus (Edgren, 1952). The penis of the male fills the cloaca of the female quite completely, although no exact lock-and-key correspondence was found. The large spines appear to serve in anchoring the penis and the minute spines may serve a similar function. The calyces of the distal, bifurcated portion of the penes may serve as suction cups, holding that portion of the penis in place. The ends of the Y-shaped sulcus spermaticus terminate at the tips of the bifurcated distal portion of the penes and serve in depositing sperm in the general areas of the oviduct openings.

Perhaps the most unusual observations which have been made on the hog-nosed snakes have been reported by Medsger (1927), who discovered two male *platyrhinos* simultaneously copulating with a single dead female. Medsger's evidence implies that the female must have been dead before copulation was attempted by the males. How coitus could be accomplished without the cooperation of the female is difficult to understand.

Clark (1952a) described oviposition in *H. platyrhinos*. The important aspects of his observations are as follows. A captive female deposited a clutch of eggs on the afternoon of 10 August. She first spent about 3½ hours making a wide U-shaped burrow in the sand of the cage and then lay with her head and tail protruding. As eggs were laid she gradually moved forward. Approximately 30 minutes elapsed between each egg during the day, whereas about 38 minute intervals obtained at night. The

average time between eggs of a second female was 27 minutes. During these intervals the "tail was curved variously and twitched near the anus. . . ." As eggs moved toward the anus the ". . . tail was arched vertically with a sharp twitch of the tail." Passage of the eggs required 12-30 seconds with the shorter times characterizing later eggs.

Territoriality

Home range and territoriality of *Heterodon* are poorly known. Stickel and Cope (1947) report recapture of a marked *platyrhinos* 100 feet from the point of release 5½ months later, which suggests that the species may not wander great distances. Dargan and Stickel (1949) estimate that their trapping experiments gathered snakes from an area three or more times the diameter of the traps (about 1300 feet); during two years of trapping 36 *platyrhinos* were taken. It seems improbable that all snakes were collected from the area, so apparently more than 36 individuals were living in an area about 4000 feet across. Certainly further marking and trapping studies on *Heterodon* are warranted.

Feeding

Extensive lists of prey selected by hog-nosed snakes are available. Regarding *simus* Carr (1940) states that the common toad is the ". . . chief and almost the only item of diet. . . ." The common toad referred to is probably *Bufo terrestris*. Carr also states that the fossorial tendencies of this snake are inconsistent with a *Bufo* diet. Goin (1947) described a *simus* about 10 inches in length digging out and eating a spadefoot toad (*Scaphiopus h. holbrooki*); it dug the toad from a burrow about 115 mm. deep. No stomach contents were found in the present study.

Breckenridge (1944) reported stomach contents of Minnesota *nasicus*. One contained two *Rana pipiens;* another had eaten a *Eumeces septentrionalis* and contained grasshopper sparrow feathers. Munro (1949a) had a specimen which ate toads, a robin, an English sparrow, and a short-tailed shrew in captivity. This specimen refused frogs. Four captive specimens during the present work ate the following species: *Hyla crucifer, Pseudacris nigrita triseriata, Rana sylvatica,* and *Acris crepitans,* although they refused a *Rana pipiens* caged with them for some weeks. According to Munro (1949a) C. B. Perkins states that *nasicus* from areas where toads are common refuse frogs; whereas those from areas where frogs are abundant refuse toads.

Data on the food habits of *platyrhinos* have been presented in Table II. Although a relatively wide variety of materials is chosen, toads seem to make up the majority of the diet of the species. Surface (1906) states that the food is made up of 41½% toads, 12½% insects, 4% birds, 33% insects from toads, 4% insects from birds and 4% salamanders. The diurnal habits of *platyrhinos* and the nocturnal habits of most toads demand special adjustments for food getting. Goin's observations on *simus* may be of general applicability. These snakes may pick up the trails left by toads during the night (Stille, 1952), follow them and dig them from their burrows or hiding places.

Toad feeding also presents the difficulty of defensive inflation of the toad; how general this habit is among toads is unknown, although it has

TABLE II

Food taken by *Heterodon platyrhinos* based upon published records. W, taken in wild; C, taken in captivity

Food Organism	Where Taken	Authority
Invertebrates		
Crickets	C	Conant, 1938a
Beetles	W	Wright and Bishop, 1915; Breckenridge, 1944
Grasshoppers	W	do; surface, 1906
Bugs	W	Breckenridge, 1944
Wasps	W	do
Ants	W	do
Stink-bug	W	Surface, 1906
Cicada	W	do
Lepidoptera	W	do
Bees	W	do
Insects	W	do
Vertebrates		
Amphibians		
Tadpole	W	do
Bufo sp.	W	do; McCauley, 1945
B. t. terrestris	W	Carr, 1940
B. t. americanus	W	Conant, 1938a; Breckenridge, 1944
B. woodhousei fowleri	W;C	Conant, 1938a; Welter and Carr, 1939
B. w. woodhousei	C	Gloyd, 1932
Rana pipiens	W	do; Breckenridge, 1944
R. clamitans	W	Breckenridge, 1944
Cricket frogs (*Acris*?)	W	Hay, 1892
Diemictylus viridescens	W	Uhler, *et al.*, 1939
Plethodon sp.	W	do
Granite Salamander	W	Surface, 1906
Reptiles		
Sceloporus undulatus	C	Anderson, 1942
Thamnophis s. sauritus	C;W	Greenhall, 1936; Surface, 1906
Tropidoclonion lineatum	C	Strecker, 1926
Birds		
Sparrow	W	Conant, 1938a
Mammals		
Rodents	?	Guthrie, 1926
Mice	C	Anderson, 1942
Microtinae	W	Uhler, *et al.*, 1939
Tamias striatus	W	do

been described by Vestal (1941) for *Bufo boreas*. Pope (1944) has suggested that the enlarged posterior maxillary teeth are utilized in puncturing and deflating toads. Minton (1944) has suggested that these teeth function in holding prey. Both hypotheses may be correct. The action of the maxillae during feeding would bring the enlarged teeth into play, and eating prey as large and active as toads would present problems in holding. These enlarged teeth may have been a factor in the success of the hog-nosed snakes as toad eaters.

Shelter

Most hog-nosed snakes have been found in the open, there being few reports of specimens taken in shelter. Neill (1948) has listed hibernacula for *platyrhinos*, and W. T. Stille informed me that he once took a specimen from under a log. Garman (1891) also reports a specimen under a log. Harold Dundee (personal communication) found a *nasicus* under a rock. Most field collectors know that *Heterodon* is seldom found under "things" used as shelter niches by other snakes. The morphology and known fossorial habits of these snakes may indicate that they burrow into soft soils for shelter.

Davis (1946) described burrowing in *platyrhinos*. In soft sand the head is bent sharply downward, applied to the smooth surface at about a 30° angle, and moved ". . . alternately from side to side." The entire process was described as follows: A specimen confined in a box of sand plowed the surface sand with direct forward thrusts, then depressed its head and burrowed with ". . . alternate lateral thrusts of the head . . ." While the snake was actively burrowing peristaltic movement of the body was noted. Four minutes after burrowing began the anterior 2/3 of the body was buried, the head was ". . . apparently performing exploratory movements . . .," but there was no additional downward movement.

In wet sand the head is held at a sharper angle to the substrate, and the quadrate bones stand out prominently as a pair of knobs at either side of the head. The anterior part of the body is arched so that the top of the head is almost vertical. The head is rotated to the side on which the thrust is to be given in order to bring the sharp anterio-lateral edge of the rostral in contact with the surface. The head is then thrust forward and laterally and rotated slightly dorsally. This movement is repeated in the opposite direction, and then alternately from one side to the other while the snake is burrowing.

Davis states that the rostral functions as a double-shared ridging plow, pushing sand to the sides as it is forced through the soil. The anterior dorsal axial musculature, which is enlarged in hog-nosed snakes, supplies power for these movements.

Similar observations were made on *Heterodon nasicus* during this study. Captives from western Illinois were observed burrowing in the sand bottom of their cage. In this species the head and rostral were applied to the surface of the substrate at a more acute angle, as would be expected from the morphology of the plate. In soft sand the head was held at an angle of almost 90°; in moist sand the head was tipped beyond a 90° angle.

It has been suggested above that the young of *nasicus* may burrow for shelter, and Breckenridge (1944) has described a specimen which burrowed to escape. One Illinois specimen, disturbed while sunning, took

refuge in an old tin can.

Although little information is available it seems logical to assume that all species of the genus resort to burrowing for shelter, and perhaps in the pursuit of food.

Natural Enemies

Little is known of the natural enemies of hog-nosed snakes, except for humans who generally consider this harmless animal to be deadly poisonous. Over (1923) states that red-tailed hawks feed *Heterodon* to their young, and Wilson and Friddle (1946) record *platyrhinos* as eaten by *Lampropeltis g. getulus* both in captivity and in the wild. Owens (1949) reports the tarantula, *Eurypelma californica,* feeding upon a young hog-nosed snake in captivity. Though these data are at best slim one might speculate that *Heterodon* is preyed upon by other snakes of various species, predaceous birds, large spiders, and perhaps mammals of various kinds.

The so-called bluffing and death feigning behavior of these snakes has been described and discussed so often that it need be considered only briefly. This pattern of behavior may be divided into two stages: the kinetic and akinetic phases. When first disturbed the kinetic or bluffing phase is initiated and marked by lateral flattening of the anterior third of the body and posterior portion of the head. A hinge mechanism of the anterior ribs allows them to extend laterally almost at a right angle to their normal position forming the "hood." With the body expanded the snake hisses and makes frequent forward thrusts of the head and anterior part of the body; each forward thrust is usually accompanied by a sharp hiss. It is generally considered that the thrusts are mock strikes; I have no record of anyone being bitten during this phase of the action. After a period of this behavior there is a marked change in activity. The mouth is gaped widely, rubbed against the ground, and has occasionally been observed to bleed slightly. The snake suddenly turns belly-up, writhes violently for a few moments and then lies still, mouth open and tongue lolling. This akinesia may be of considerable duration as Halton (1931) states, "I have watched it simulate death for forty-five minutes." At the end of this phase the snake surveys the area with slight movements of the head, and if all is clear will right itself and crawl away; if it observes a person moving nearby it remains motionless. During akinesia the belly-up position is maintained; if turned over the snake will immediately flip over onto its back. When picked up an akinetic individual will remain limp and can be carried for some time in this condition. Information of great value can be provided by observations on the duration of akinesia in the field under differing environmental conditions. In captivity the behavior is rapidly lost and adequate field data come only by chance. An apparent exception to the former statement was a *platyrhinos* maintained in captivity by Dr. Orlando Park (personal communication); this snake obligingly demonstrated the behavior for Dr. Park's classes for over a year.

During the thrusting activity of *platyrhinos* the mouth is held slightly open. Dr. Karl P. Schmidt (personal communication) states that the mouth of *nasicus* is gaped widely during this phase, but that otherwise the behavior is similar to that described for *platyrhinos*. *Heterodon nasicus* which I have collected have made no attempt to go through this

activity, but instead seemed to try to hide their heads beneath coils of the body. Hudson (1942) reports a similar lack of the behavior in *nasicus*. Gloyd (1928) reports that only one in four *platyrhinos* went through the pattern, whereas all adults I have collected in the wild "played 'possum." There are no literature descriptions of this behavior in *Heterodon simus*, but it may be presumed to exhibit it under favorable conditions.

The reason for this pattern of activity demands further study. From the evolutionary point of view our lack of knowledge of the response of these snakes to potential predators other than man makes speculations tenuous. One could hardly believe that such a complex series of actions could have evolved in the short period of time humans have been present in North America, which was apparently invaded by man during the late Pleistocene (Simpson, 1947). It seems highly improbable that the activity patterns were evolved in response to man, and until data on the effects of *bluffing* on possible predators become available speculation seems of little use. Certainly such an animal as a skunk would not be deterred by the apparent death of potential prey.

The psycho-physiological dynamics of this behavior also present interesting problems. Minton (1944) has suggested that the activity may be volitional, or perhaps akin to human narcolepsy. Dickinson (1948) has observed death feigning in *Naja haje*, and Hulme (1951) has described it in Ringhals. Hulme suggests that letisimulating snakes have "fainted." How widely the behavior is distributed among cobras is not known. Hartman (1950) believed that akinesia is the effect of chemical substances diffusing from nervous centers; these substances eventually would be destroyed by enzymatic or oxidative action. The latter suggestion seems most plausible in view of the effects of hormones in fear and stress reactions in vertebrates. In an effort to test this hypothesis (Edgren and Edgren, 1955) the neurohumors sympathin E (nor-epinephrine) and acetylcholine and the adrenal hormone epinephrine were administered parenterally to a *platyrhinos*. The actions were not stimulated although large quantities were injected. Although these substances are apparently inactive peripherally, and the adrenal medulla seems ruled out, the central nervous effects of nor-epinephrine and acetylcholine cannot be discounted by these experiments. Direct central application is warranted; however, it seems best at present to consider these activities as central reflex patterns, which are hardly amenable to experimental study at this time.

Parasites and Disease

In this study mites were seen on all three species of *Heterodon*, although none of them was identified. Host examinations on *nasicus* have produced no parasites; however, these specimens had been maintained in captivity without food for some time prior to examination, which may explain the lack of parasites. Nematodes have been taken from several specimens of *platyrhinos*. Wright and Bishop (1915) note that two thirds of the specimens which they examined had stomach parasites, and suggest that these may result from the highly anuran diet. Parker (1941) recorded the trematodes *Renifer ellipticus* and *Neorenifer validus* from *platyrhinos*, and Goodman (1951) reported a common hog-nosed snake which contained hundreds of trematodes in the lungs with no apparent effect upon the snake's health. Goodman suggested that the renifers so common in snakes have little effect upon host health.

LITERATURE CITED

Anderson, Paul
1942. Amphibians and reptiles of Jackson County, Missouri. Bull. Chicago Acad. Sci., 6(11): 203-220.

Breckenridge, W. J.
1944. Amphibians and reptiles of Minnesota. Univ. Minnesota Press: xiii, 1-202.

Cagle, F. R.
1942. Herpetological fauna of Jackson and Union Counties, Ill. Amer. Midl. Nat., 28(1): 164-200.
1953. An outline for the study of a reptile life history. Tulane Studies Zoöl., 1(3): 31-52.

Carr, A. F., Jr.
1940. A contribution to the herpetology of Florida. Univ. Florida Publ., 3(1): 1-118.

Clark, H.
1952a. Note on the egg-laying habits of *Heterodon platyrhinos* (L.). Herpetologica, 8(2): 28-29.
1952b. A preliminary ovimetric study of *Heterodon platyrhinos* (L.). Ibid.: 29-32.

Conant, Roger
1938a. The reptiles of Ohio. Amer. Midl. Nat., 20(1): 1-200.
1938b. On the seasonal occurrence of reptiles in Lucas County, Ohio. Herpetologica, 1(5): 137-144.

Dargan, L. M. and W. H. Stickel
1949. An experiment with snake trapping. Copeia, 4: 264-268.

Davis, D. D.
1946. Observations on the burrowing behavior of the hog-nosed snake. Ibid., 2:75-78.

Dickinson, W. H.
1945. On "spitting" cobras. Herpetologica, 3(1): 28-30.

Edgren, R. A.
1952. Copulatory adjustment in snakes and its evolutionary implications. Copeia, 3: 162-164.
and Margery K. Edgren 1955 Experiments on bluffing and death-feigning in the hog-nosed snake, *Heterodon platyrhinos*. In press.

Fitch, H. S.
1949. Outline for ecological life history studies of reptiles. Ecology, 30(4): 520-532.

Franklin, M. A.
1945. The embryonic appearance of centres of ossification in the bones of snakes. Copeia, 2: 68-72.

Garman, H.
1891. A synopsis of the reptiles and amphibians of Illinois. Bull. Ill. St. Lab. Nat. Hist., 3: 215-389.

Gloyd, H. K.
1928. The amphibians and reptiles of Franklin County, Kansas. Trans. Kansas Acad. Sci., 31:115-141.

1932. The herpetological fauna of the Pigion Lake Region, Miami County, Kansas. Papers Michigan Acad. Sci., Arts, Letters, 15: 389-409.

Goin, C. J.
1947. A note on the food of *Heterodon simus*. Copeia, 4: 275.

Goodman, J. D.
1952. Some aspects of the role of parasitology in herpetology. Herpetologica, 7(2): 65-67.

Greenhall, A. M.
1936. A cannibalistic hog-nosed snake. Copeia, 3: 171.

Guthrie, J. E.
1926. The snakes of Iowa. Bull. Iowa State Exper. Sta., 239: 1-11, 147-192.

Haltom, W. L.
1931. Alabama reptiles. Alabama Mus. Nat. Hist., Mus. Paper 11: vi, 1-145.

Hartman, C. G.
1950. Playing 'possum. Scientific Amer.: 52-55.

Hay, O. P.
1892. The batrachians and reptiles of the state of Indiana. Ann. Rep. Indiana Dept. Geol. Nat. Res., 17: 409-610.

Hudson, G. S.
1942. The amphibians and reptiles of Nebraska. Nebraska Cons. Bull., 24: 1-146.

Hulme, J. H.
1951. The "playing possum" habits of the ringhals cobra. Herpetologica, 7(3): 132.

Logier, E. B. S.
1939. The reptiles of Ontario. Royal Ontario Mus. Zoöl., handbk., 4: 1-63.

McCauley, R. H., Jr.
1945. The reptiles of Maryland and the District of Columbia. Printed by the author: Hagerstown, Md.: 1-194.

Medsger, O. P.
1927. The hog-nosed snake or puff adder. Copeia, 160: 180-181.

Minton, Sherman, Jr.
1944. Introduction to the study of the reptiles of Indiana. Amer. Midl. Nat., 32(2): 438-477.

Munro, D. F.
1949a. Food of *Heterodon nasicus nasicus*. Herpetologica, 5(6): 133.
1949b. Gain in size and weight of *Heterodon* eggs during incubation. Ibid.:133-134.
1949c. Hatching of a clutch of *Heterodon* eggs. Ibid.: 134-136.

Neill, W. T.
1948. Hibernation of amphibians and reptiles in Richmond County, Georgia. Ibid., 4(3): 107-114.

Noble, G. K. and E. R. Mason
1933. Experiments on the breeding habits of *Eumeces* and *Ophisaurus*. Amer. Mus. Nov., 619: 1-29.

Over, W. H.
1923. Amphibians and reptiles of South Dakota. South Dakota Geol. Nat. Hist. Surv. Bull., 12: 1-34.

Owens, Virgil
1949. Snakes eaten by the tarantula, *Eurypelma californica.* Herpetologica, 5(6): 148.

Parker, M. V.
1941. The Trematode parasites from a collection of amphibians and reptiles. Jour. Tennessee Acad. Sci., 16(1): 27-45.

Pope, C. H.
1944. Amphibians and reptiles of the Chicago area. Chicago Nat. Hist. Mus.: 1-275.

Price, W. H. and L. G. Carr
1943. Eggs of *Heterodon simus.* Copeia, 3: 193.

Simpson, G. G.
1947. Holarctic mammalian faunas and continental relationships during the Cenozoic. Bull. Geo. Soc. America, 58: 613-688.

Stickel, W. H. and J. B. Cope
1947. The home ranges and wanderings of snakes. Copeia, 2: 127-136.

Stille, W. T.
1952. The nocturnal amphibian fauna of the southern Lake Michigan beach. Ecology, 33(2): 149-162.

Strecker, J. K.
1926. Chapters from the life-histories of Texas reptiles and amphibians. Contr. Baylor Univ. Mus., 8: 1-12.

Surface, H. A.
1906. The serpents of Pennsylvania. Pennsylvania St. Dept. Agric., Monthly Bull. Div. fool., 4: 113-202.

Uhler, F. M., C. Cottam and T. E. Clarke
1939. Food of snakes of the George Washington National Forest, Virginia. Trans. 4th North American Wildlife Cong.: 605-622.

Vestal, E. H.
1941. Defensive inflation of the body in *Bufo boreas halophilus.* Copeia, 3: 183.

Welter, W. A. and Katherine Carr
1939. Amphibians and reptiles of northeastern Kentucky. Ibid., 3: 128-130.

Wilson, L. W. and S. B. Friddle
1946. Notes on the king snake in West Virginia. Ibid., 1: 47-48.

Wright, A. H. and S. C. Bishop
1915. A biological reconnaissance of the Okefinokee Swamp in Georgia. II—Snakes. Proc. Acad. Nat. Sci., Philadelphia: 139-192.

CRESAP BIOLGICAL LABORATORY, NORTHWESTERN UNIVERSITY (PRESENT ADDRESS: DIVISION OF BIOLOGICAL RESEARCH, G. D. SEARLE AND CO., CHICAGO, ILLINOIS)

The Identity of the Trans-Isthmic Mexican Populations of the Malachite Tree Lizards (*Sceloporus malachiticus* Cope)

By HOBART M. SMITH and CARLOS B. BUMZAHEM

In a recent review of populations of *Sceloporus malachiticus* from southern Mexico (Journ. Washington Acad. Sci., 39: 38-40, 1949) it was pointed out that three subspecifically related groups occur in Chiapas, Oaxaca and Veracruz: (1) *Salvini* Günther from the foothills of eastern Veracruz and northern Oaxaca, east of the Isthmus of Tehuantepec, with Santo Domingo, Oaxaca, being the locality of record closest to the Isthmus; (2) *acanthinus* Bocourt of the foothills of southern Chiapas; and (3) *taeniocnemis* Cope of the central plateau of Chiapas. Intergrades between *taeniocnemis* and *acanthinus* are recorded from intermediate altitudes in southern Chiapas; others are now available from Cerro Baul, extreme southwestern Oaxaca (UIMNH).

The contribution to this picture of the specimens here reported is the recognition of another subspecies inhabiting the foothills of the northern slopes of the Chiapas plateau, presumably along its entire length although we have seen specimens from but a single locality. A total of 11 specimens have been available of this form, and seven are now at hand. This population was previously reported *(loc. cit.)* as an intergrade between *S. m. salvini* and *S. m. taeniocnemis*, but at the time only one adult (a female) was available. The six adults now available clearly indicate the unique nature of the small internasals previously recorded. With a reasonable geographic niche available for it, we regard it a reasonable assumption that a hitherto undescribed subspecies of the *malachiticus* complex is involved. In reference to its most distinctive feature we name it

Sceloporus malachiticus internasalis subsp. nov.

Holotype. University of Illinois Museum of Natural History No. 35617, a female from La Gloria, Oaxaca, collected March 12, 1953, by Mr. Thomas MacDougall. *Paratypes.* Six, UIMNH No. 35718-35620, USNM No. 135436, same data as holotype, UIMNH 21326-7, juveniles, same locality but collected Feb. 23-27, 1940.

Diagnosis. A *Sceloporus* closely related to *Sceloporus m. malachiticus*, with supraoculars in one row; median frontonasal separated from lateral frontonasals; dorsal scales large; shoulder patches absent or if present separated dorsally by 6 or 7 scale rows; no supraoculars in contact with median head scales; 2 rows of scales between nasals and rostral; 2 rows of scales between nasals and first labial; internasal area broken up into many very small, rounded scales.

Description of holotype. Color above (in alcohol) light brown on body and limbs, tail gray-brown, upper surface of head with scattered light spots, dark shoulder patches separated by 7 scale rows dorsally and by 2 or 3 rows ventrally; ventral surfaces gray, tinged with light brown. Median frontonasal separated from lateral frontonasals; 2 rows of small scales between nasals and rostral and 2 rows also between nasals and labials; internasal area broken up into many small, rounded scales,

extending from rostral to median frontonasal; elongate subocular slightly longer than horizontal diameter of eye; 2 rows of lorilabials between subocular and labial row; a single preocular, loreal, and canthal on each side; supraoculars in one row; no supraoculars in contact with median head scales; dorsal scales large, 33 from interparietal to level of posterior insertion of hind limbs; femoral pores 12-12.

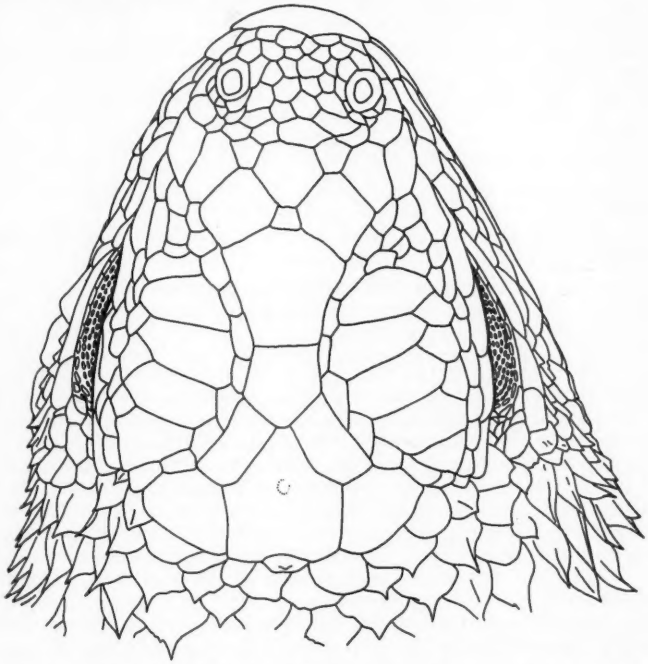

FIG. 1. Dorsal head scales of *Sceloporus malachiticus internasalis*. From type, UIMNH No. 35617. Drawing by Charles A. McLaughlin.

Snout-vent measurement 80 mm.; head to posterior edge of ear opening 22 mm.; axilla to groin 30 mm.; leg to tip of longest toe 59 mm.

Variation. All paratypes agree essentially with the holotype in scutellation. One, USNM No. 135436, has the median frontonasal separated from the lateral frontonasal on one side only. Dorsal scale count varies from 34 to 36, no paratypes with 33; all have the internasal area broken up into small, rounded scales. The coloration (in alcohol) varies somewhat. Three have a generally brownish dorsal coloration with a blue-gray tinge; one has a light brown coloration like the holotype, but also has an extraordinary hood, with the entire anterior half of the body, as far posteriorly as a few millimeters back of the axilla, colored uniform black. The two juveniles have a dark brown dorsal coloration covering

all the upper parts, and light ventral surfaces. Some of the adults have a darker blue gray head instead of the light brown of the holotype, but all show at least traces of spotting. The distance between dark shoulder patches varies and is in one or two cases very indistinct.

Comparisons. Specimens of all Mexican subspecies of *Sceloporus malachiticus* have been available for comparison. *Sceloporus m. internasalis* may be distinguished from *salvini* by its lack of a complete nuchal collar or a collar separated by only one scale row, a much lower dorsal scale count, and supraoculars in a single row. It differs from *acanthinus* by having no supraoculars in contact with the median head scales, no broad, nearly complete nuchal collar, and median frontonasal not in contact with lateral frontonasals. It may be separated from *taeniocnemis* by its lower dorsal scale count, and supraoculars in one instead of two rows. *Sceloporus m. internasalis* differs from all in having the internasal area broken up into small rounded scales, and two rows of scales between nasals and rostral (also between nasals and labials).

We wish to thank Dr. Doris M. Cochran and the U. S. National Museum for the loan of specimens of *salvini* for comparison.

MUSEUM OF NATURAL HISTORY,
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SOUNDING TURTLES: A FIELD LOCATING TECHNIQUE.—The following technique was developed at the Oliver Wildlife Preserve of the University of Oklahoma. Those who have searched for box turtles, are aware of their habit of hiding under piles of sticks and leaves, or of digging forms in the soft earth. In searching for reptiles on the preserve, I customarily carry a beating-stick so that individuals can be flushed from a larger area. When working in thicket areas, I began to use this stick to prod the masses of leaves and debris caught at the bases of bushes and briar, in tree roots, washes or small hollows. I quickly discovered that if a turtle was present, the stick striking the carapace made a hollow sound easily discernible from that of a piece of wood or stone. This stick was later replaced by a more efficient cane-like rod of aluminum tubing tapered to a blunt point.

With the approach of cool weather in the fall, the turtles became less and less active as they entered hibernation. This "sounding" rod continued to be very effective in locating the turtles down to their usual depth of six to ten inches beneath the debris or soil (some "sounded" up to twenty inches). Searches were continued throughout the winter using this method, and during this time more than one hundred individual turtles were found in their hibernacula.

This method was effective in locating all five species of turtles known to be on the preserve: *Terrapene carolina triunguis, Terrapene ornata, Kinosternon f. flavescens, Chelydra s. serpentina,* and *Pseudemys scripta elegans.*

This turtle "sounding" technique offers an effective method of locating turtles resting, aestivating, or in hibernation, when they are covered by debris in their forms or buried deep in the ground.—Charles C. Carpenter, Department of Zoology, University of Oklahoma, Norman.

Amphibians and Reptiles Collected in Mexico in the Summer of 1953

By PETE S. CHRAPLIWY *and* CHARLES M. FUGLER

The herpetofauna of parts of Mexico is so little known that it is deemed worthwhile to place on published record the specimens obtained by a field party from the University of Kansas in the summer of 1953. Some of the least-known parts of northern Mexico were visited as well as the coastal states of central and southern Mexico. Two hundred and thirty-five specimens representing fifty-four species and subspecies were taken in seven states of Mexico (Chihuahua, Coahuila, Durango, Nayarit, Oaxaca, Puebla, and Sinaloa) in the period from June 14 to August 5. Twelve species and subspecies of amphibians numbering 68 specimens, and 42 species and subspecies of reptiles (2 of turtles, 29 of lizards, and 11 of snakes) numbering 167 specimens were preserved by the expedition.

Species and subspecies for the first time recorded from certain states are as follows: Chihuahua, *Kinosternon flavescens stejnegeri, Pseudemys scripta gaigeae, Coleonyx brevis, Cnemidophorus sacki semifasciatus,* and *Rhinocheilus lecontei tessellatus;* Coahuila, *Thamnophis eques megalops* and *Urosaurus ornatus schmidti;* Oaxaca, *Cnemidophorus sacki communis;* Puebla, *Cnemidophorus sacki australis.* In addition, three species, *Sceloporus ornatus caeruleus, Urosaurus ornatus schmidti,* and *Crotalus pricei pricei,* are of interest for other reasons, as explained below. All specimens, unless otherwise indicated, are in the Museum of Natural History, University of Kansas, to which the catalogue numbers refer.

The field work was under the direction of Dr. Rollin H. Baker, and the members of the field party were John R. Esther, John Keever Greer, and William M. Lynn.

We are indebted to Dr. Edward H. Taylor for his assistance in our study, to Mr. W. Leslie Burger for suggestions and some identifications, to Dr. Rollin H. Baker for ecological data and other aid, and to Dr. E. Raymond Hall for critical assistance with the manuscript.

Most of the localities at which collections were made may be found by consulting the maps issued by the American Geographical Society and the National Geographic Society's Map of Mexico and Central America, March, 1953.

The field work was financed by the University of Kansas Endowment Association and the National Science Foundation.

ACCOUNT OF SPECIES AND SUBSPECIES

Spea hammondi multiplicata (Cope). Chihuahua: Las Arenosas (Nos. 33938-48) and 2 mi. SE Hechicero (Nos. 33949-50). All were taken in water. The last two listed were recovered from a stock tank.

Bufo woodhousei woodhousei Girard. Chihuahua: Nos. 33830-35 were secured at the junction of the Río San Pedro and the Río Conchos, 5 mi. N and 5 mi. E Meoqui. They were taken at night on the banks of the rivers.

Bufo compactilis compactilis Wiegmann. Durango: 7 mi. SW Las Adjuntas, elevation 8,900 feet (No. 33915), and 2 mi. NE Coyotes (Nos. 33901-02). They agree well with the description by Smith (1947)

except that the specimen first listed has low and poorly defined cranial crests.

Bufo cognatus Say. Chihuahua: A stock tank 2 mi. SE Hechicero (Nos. 33916-18), and a lake at Las Arenosas (Nos. 33919-34).

Bufo marinus Linaeus. Oaxaca: No. 33905 was found hopping on the lawn of the Tehuantepec Hotel in late afternoon. It measures 144 mm. from snout to vent. Rollin H. Baker states that the species is rather common in the lowland arid portions of Oaxaca.

Bufo mazatlanensis mazatlanensis Taylor. Sinaloa: Mazatlán (No. 33936). It measures 69 mm. from snout to vent, possesses a well-developed occipital crest, and in other characteristics agrees with the subspecies as described by Langebartel and Smith (1954).

Bufo mazatlanensis nayaritensis Taylor. Nayarit: One individual measuring 74 mm. from snout to vent was secured in Tepic (No. 33937). It is distinctly darker, the body tubercles are larger, and the outer metatarsal tubercles are larger than our example of the preceding subspecies. The occipital crest is well developed. These features comprise the basis upon which the specimen is assigned to *B. m. nayaritensis* as defined by Langebartel and Smith *(op. cit.)*.

Bufo valliceps Wiegmann. Oaxaca: Nine specimens (Nos. 33813-21) were collected from roadside ditches 16 mi. N Matias Romero.

Leptodactylus labialis (Cope). Oaxaca: No. 33877 was found in a roadside ditch 16 mi. N Matias Romero.

Smilisca baudini (Duméril and Bibron). Oaxaca: Nos. 33822-29 taken 16 mi. N Matias Romero. The species was abundant. Many were observed on low branches of dense second growth vegetation in the company of *Hyla staufferi*.

Hyla staufferi Cope. Oaxaca: Nos. 33878-82 secured from low bushes adjacent to roadside ditches 16 mi. N Matias Romero.

Rana pipiens Schreber. Coahuila: No. 33797 obtained in an arroyo at 4,650 feet in the Sierra de los Hecheros, 3 mi. S and 8 mi. E Hechicero, a puebla in Chihuahua.

Kinosternon flavescens stejnegeri Hartweg. Chihuahua: One individual (No. 33914) obtained in an arroyo at Las Arenosas in Lago de los Patos. The gular is more than half the length of the anterior lobe of the plastron (58%) as is typical of the race. The anterior lobe of the plastron is shorter than the combined lengths of the gular and the interfemoral suture plus the width of the nuchal (83%).

The characters of this specimen differ from those given in the diagnosis of the subspecies by Hartweg (1938) only in having a smaller nuchal; in this respect our specimen agrees with the paratypes from Durango (EHT Nos. 4573-77). To our knowledge, this individual constitutes the first record of the subspecies from the state of Chihuahua.

Pseudemys scripta gaigeae Hartweg. Chihuahua: A young specimen, No. 33884, seined from the water at the junction of the Río San Pedro and the Río Conchos, 5 mi. N and 5 mi. E Meoqui, is the first record for this subspecies for the state. *P. s. gaigeae* was previously known only from San Pedro in Coahuila and the Río Nazas in Durango. Hamilton (1947) predicted the presence of this subspecies in Chihuahua since the Río Conchos and its tributaries are part of the Río Grande system, entering the Río Grande near Presidio, Texas. The Río Nazas, however, is not a

part of this drainage system, but an independent stream draining into the Laguna de Mayran. The presence of the subspecies in similar drainage systems in the arid parts of northern Mexico is therefore probable.

In our specimen the ocelli are well defined at the posterior medial border of the lateral and marginal scutes. Measurements are as follows: Length of carapace from nuchal to anal plate, 61 mm.; length of plastron, 55 mm.; width of carapace (measured from middle of bridge), 37 mm. There are two longitudinally parallel lines on the bridge.

Coleonyx brevis Stejneger. Chihuahua: No. 33874, 2 mi. N and 6 mi. E Camargo. This specimen is the first record of the species in the state. It was taken at night in a mouse trap on the floor of the desert.

Phyllodactylus muralis Taylor. Oaxaca: No. 33873, from 5 mi. NW Totolapam, at an elevation of 4,350 feet. It was found in a culvert beneath a road. The following data were recorded: Snout to vent length, 59 mm.; postmental in contact with first lower labial; 22 scales between eyes; 8 scales bordering postmental. No color pattern is evident.

Anolis tropidonotus Peters. Oaxaca: No. 33854, 2 mi. S Tollosa, from tropical rainforest, measures 51 mm. from snout to vent. The supraorbitals are separated by 3 rows of scales.

Anolis nebuloides Bocourt. Oaxaca: No. 33853, from 2 mi. N and 10 mi. W Tehuantepec, measures 49 mm. from snout to vent and has 3-4 enlarged supraoculars. The circumorbitals are separated by one row of scales. The specimen was taken in a thorn scrub forest.

Ctenosaura pectinata (Wiegmann). Sinaloa: 1 mi. NW Escuinapa (No. 33909); 3 mi. NE Concordia (No. 33908); 6 mi. SE Rosario (No. 33907). Puebla: 9 mi. NW Acatlán (No. 33910); 10 mi. NW Acatlán (No. 33906). The specimens were shot as they sat on large boulders along the side of the road.

Holbrookia texana scitula Peters. Coahuila: 7 mi. NE Jaco, Chihuahua (No. 33841); 6 mi. S Castillón (Nos. 33774-75). Chihuahua: 6 mi. W and 2 mi. S Hechicero (No. 33837); 2 mi. SE Hechicero (No. 33780); 3 mi. N and 2 mi. E Las Arenosas (No. 33773); 4 mi. N and 2 mi. W Ciudad Chihuahua (Nos. 33777-78); 4 mi. N and 1 mi. W Ciudad Chihuahua (No. 33776); 1 mi. W Noria de la Blanca (Nos. 33838, 33842); 10 mi. S and 1 mi. E Encinallas (Nos. 33836, 33839); 1 mi. S San Francisco (No. 33840); 3 mi. N (No. 33844) and 20 mi. S (No. 33843) Gallegos; 5 mi. N and 5 mi. E Meoqui (Nos. 33772, 33781-83). Durango: 3 mi. SW Lerdo (No. 33779).

Except for a minor variation in the number of ventral pores in certain individuals, the specimens agree well with the original description of *H. t. scitula* by Peters (1951). The following data were recorded: Number of ventrals, males 71-88, females 72-87; number of scales in head length, males 35-44, females, 30-44; sum of femoral pores, males, 22-33, females, 21-30. In each of five males the femoral pores total 24 or less. The minimum reported by Peters *(op. cit.)* in 146 males was 25.

Crotaphytus collaris baileyi Stejneger. Chihuahua: 2 mi. SW Victoria (No. 33788); 5 mi. S Hechicero (No. 33789). Durango: 3 mi. SW Lerdo (No. 33787).

Crotaphytus wislizeni wislizeni (Baird and Girard). Chihuahua: 8

mi. NW Jaco (No. 33784). Coahuila: 3 mi. N and 4 mi. E El Pino (No. 33786); 12 mi. NE Jaco, Chihuahua (No. 33785). These specimens were obtained along the road under cacti and creosote bushes in arid situations.

Phrynosoma cornutum (Harlan). Coahuila: 3 mi. W Castillón (No. 33793); 5 mi. NW (No. 33794) and 5 mi. S and 1 mi. E Tanque Alvarez (No. 33795).

Phrynosoma modestum Girard. Coahuila: 6 mi. N Castillón (No. 33792). Chihuahua: 4 mi. N and 2 mi. W Ciudad Chihuahua (Nos. 33790-91). The specimens from Chihuahua were taken in an arroyo bordering the road.

Sceloporus magister magister Hallowell. Coahuila: 2 mi. SSE Castillón (No. 33806) from beneath a mesquite bush.

Sceloporus horridus horridus Wiegmann. Oaxaca: 2 mi. NW Tamazulápam (No. 33807). It measures 94 mm. from snout to vent. The specimen was shot at night on a low branch of a tree.

Sceloporus undulatus consobrinus Baird and Girard. Coahuila: 7 mi. NE Jaco (No. 33860); 2 mi. SSE Castillón (No. 33857). Chihuahua: 4 mi. N and 2 mi. W Ciudad Chihuahua (Nos. 33858-59); 5 mi. N and 5 mi. E Meoqui (Nos. 33861-64).

Sceloporus grammicus microlepidotus Wiegmann. Puebla: 11 mi. WNW San Martín Texmelucan (No. 33805) near the lower edge of the coniferous forest at an elevation of 9,100 feet. The following data were recorded: Snout to vent length, 62 mm.; 4 postrostrals; 1-2 loreals; prefrontals in contact medially; preoculars entire; 84 dorsal scale rows; 15-14 femoral pores; dorsal color blue-gray changing to cyanine blue laterally.

Sceloporus grammicus disparilis Stejneger. Durango: 7 mi. SW Las Adjuntas (Nos. 33798-33802); 2 mi. E El Salto (No. 33803).

Sceloporus poinsetti Baird and Girard. Chihuahua: 1 mi. S Hechicero (No. 33811). Coahuila: 3 mi. S and 8 mi. E Hechicero, Chihuahua (No. 33856). Durango: 4 mi. SW Coyotes, at an elevation of 9,100 feet (No. 33855). The specimen from Durango differs from typical examples in having 27 dorsal scale rows.

Sceloporus ornatus caeruleus Smith. Coahuila: One specimen from 26 mi. SW San Pedro de las Colonias (No. 33865). This subspecies was previously known only from the type locality (5 mi. S San Pedro, Coahuila).

This is the first report of this subspecies since the original description by Smith (1936). The following data were recorded: Snout-vent length, 55 mm.; supraoculars in two rows; prefrontals in contact medially; preocular divided; posterior section of frontal completely divided; 49 dorsal scale rows; 14-13 femoral pores.

Sceloporus teapensis Günther. Oaxaca: 2 mi. S Tollosa (No. 33796). It measures 59 mm. from snout to vent, has 43 dorsal scale rows, 13-13 femoral pores, anterior frontal divided longitudinally, posterior frontal entire, 6-6 supraoculars, and the prefrontals not in contact medially.

Sceloporus siniferus siniferus Cope. Oaxaca: 10 mi. W and 2 mi. N Tehuantepec (No. 33883). This specimen was taken in an area of thorny brush near the edge of a dense forest.

Urosaurus ornatus schmidti (Mittleman). Coahuila: 3 mi. S and 8 mi. E Hechicero, Chihuahua (No. 33846); 12 mi. N and 10 mi. E Parras

(No. 33845). Chihuahua: 37 mi. S and 3 mi. W Ciudad Juárez (Nos. 33847-48, 33913).

These specimens are of special interest in that they verify the presence of the subspecies in northern Chihuahua and are recorded from Coahuila for the first time. Four subspecies of *ornatus* are now known from northern Mexico: *ornatus, schmidti, linearis,* and *caeruleus.*

The arrangement of the dorsal scales in our specimens differs from that in the subspecies *ornatus,* which has the scales of the primary series approximately twice as large as the scales of the secondary series. Our specimens differ from the subspecies *caeruleus* by the presence of enlarged dorsals extending onto the basal portion of the tail for a distance nearly half the length of the femur, and the largest dorsals are equal to or larger than the femorals.

Mittleman (1942) reports that the only *bona fide* record of *U. o. schmidti* for Chihuahua is a specimen from near Samalayuca reported by Smith (1935). The five specimens included in this collection constitute the first record of this subspecies in Chihuahua since Mittleman (1940) described the subspecies on the basis of twenty-four specimens.

Our specimens agree well with the original description of *U. o. schmidti.* However, in regard to the point of origin of the enlarged dorsal scales and the ventral color pattern, the differences between *schmidti* and *caeruleus* are not so distinct as reported by Mittleman (1942). Examination of the type of *U. o. caeruleus* (No. 19237) reveals that the enlarged dorsals commence well caudad, and not slightly craniad, from a line joining the anterior points of the insertion of the arms as reported by Mittleman *(op. cit). U. o. schmidti* agrees with *caeruleus* in this characteristic.

Mittleman (1941) pointed out the close relationship between *schmidti* and *caeruleus,* and mentioned that he had seen specimens which are undoubtedly intergrades of these two subspecies.

Our specimens have the dorsal color pattern typical of the subspecies *schmidti.* The ventral surfaces of the body, except the chest, base of tail, and interfemoral area are dark blue-gray in three males, and flecked with gray in the fourth, thus approaching *caeruleus* in which these areas are sky blue. The gular region, including the sublabials, is heavily flecked with gray in all four males. The single female has a light blue venter and the interhumeral, interfemoral, and gular regions are lightly flecked with gray.

Uta stansburiana stejnegeri Schmidt. Coahuila: 7 mi. NE Jaco, Chihuahua (No. 33889); 12 mi. N and 10 mi. E Parras (Nos. 33887-88). Chihuahua: Las Arenosas (Nos. 33885, 33890); 28 mi. S and 2 mi. W Ciudad Juárez (Nos. 33886, 33891-94).

Mabuya mabouya alliacea Cope. Oaxaca: 12 mi. S and 5 mi. E Nejapa (No. 33804) in a pine-oak forest. We have followed Burger (1952) in his segregation of the Mexican and Central American subspecies of *M. mabouya.*

Cnemidophorus deppei deppei Wiegmann. Oaxaca: 10 mi. W and 2 mi. N Tehuantepec (Nos. 33719, 33721); 3 mi. W and 1 mi. N Tehuantepec (No. 33720). The lizards were found in a thicket of thorny brush at the edge of a dense scrub forest.

Cnemidophorus guttatus immutabilis Cope. Oaxaca: 17 mi. W Te-

huantepec (No. 33713); 9 mi. NW Tehuantepec (No. 33714); 10 mi. W and 2 mi. N Tehuantepec (Nos. 33715-17); 3 mi. W Tehuantepec (No. 33718).

Cnemidophorus sacki australis Gadow. Puebla: 12 mi. NW Tehuitzingo (No. 33753). The specimen was taken in an area containing thorny brush. The cross-barred pattern of this specimen, which measures 303 mm. total length and 85 mm. snout to vent length, contrasts with the light spots of *communis*, the only other subspecies of *C. sacki* previously reported from the State.

Cnemidophorus sacki communis Cope. Coahuila: 26 mi. SW San Pedro de las Colonias (No. 33809). Durango: 3 mi. SW Ciudad Lerdo (Nos. 33766, 33769). Sinaloa: 7 mi. SW Concordia (No. 33810). Oaxaca: 12 mi. S and 5 mi. E Nejapa (No. 33808). *C. s. communis* has not been previously recorded from Oaxaca.

Cnemidophorus sacki stictogrammus Burger. Coahuila: 7 mi. NE Jaco, Chihuahua (No. 33896); 10 mi. NW Tanque Alvarez (No. 33771); 9 mi. N and 6 mi. W Castillón (No. 33722). Chihuahua: 2 mi. SE Hechicero (Nos. 33723, 33725-27, 33899); 4 mi. E and 4 mi. N Meoqui (No. 33758); 5 mi. E and 5 mi. N Meoqui (Nos. 33756, 33764, 33770); 1 mi. S San Francisco (Nos. 33760, 33765); 3 mi. N Gallegos (No. 33900); 37 mi. S and 3 mi. W Ciudad Juárez (No. 33761); 19 mi. S (No. 33897) and 20 mi. S Gallegos (No. 33898); 4 mi. N and 2 mi. W (No. 33762) and 16 mi. S and 12 mi. E Ciudad Chihuahua (No. 33763); 4 mi. S and 1 mi. E Moctezuma (No. 33895).

Cnemidophorus sacki semifasciatus Cope. Coahuila: 3 mi. S and 8 mi. E Hechicero, Chihuahua (Nos. 33755, 33759). Chihuahua: 2 mi. SE Hechicero (Nos. 33754, 33757, 33767-68). The specimens from Chihuahua represent the first record of the subspecies from the state.

Cnemidophorus tigris marmoratus Baird and Girard. Coahuila: 12 mi. N and 10 mi. E Parras (No. 33746); 2 mi. SW Carricitos (No. 33736); 7 mi. NE Jaco, Chihuahua (Nos. 33728-30, 33732, 33734, 33738, 33741, 33743-44, 33749-51); 2 mi. SSE Castillón (Nos. 33733, 33735, 33747). Chihuahua: 1 mi. N and 3 mi. E Camargo (Nos. 33740, 33748); 2 mi. N and 6 mi. E Camargo (Nos. 33742, 33745, 33752); 37 mi. S and 3 mi. W Ciudad Juárez (Nos. 33731, 33737, 33739).

Elaphe guttata emoryi (Baird and Girard). Coahuila: 9 mi. N and 6 mi. W Castillón (No. 33872). The following data were recorded: 25-27-21 scale rows; 72 caudals; 8-8 supralabials; 38 body blotches; 16 tail blotches; total length, 584 mm.;; and tail length, 106 mm. The specimen was taken at the base of a volcanic outcrop.

Hypsiglena ochrorhyncha ochrorhyncha Cope. Chihuahua: 4 mi. N and 2 mi. W Ciudad Chihuahua (No. 33875). It has 178 ventrals, 44 caudals, 21-21-16 scale rows, and measures 445 mm. in total length, 67 mm. in tail length. The specimen was taken at night in an arroyo.

Pituophis melanoleucus sayi (Schlegel). Coahuila: 2 mi. S and 5 mi. E Hechicero, Chihuahua (No. 33911). It measures 1522 mm. in total length and 163 mm. in tail length. This specimen was captured by ranchers near Hacienda Rincón in the dry and rocky foothills of the Sierra de los Hecheros.

Rhinocheilus lecontei tessellatus Garman. Chihuahua: 28 mi. S and 12 mi. W Ciudad Juárez (No. 33935). This subspecies has been reported previously from the states of Nuevo León and Coahuila. It was captured at night in an area characterized by mesquite.

The following data were recorded: Dorsal body blotches (beginning with the postoccipital blotch), 32; tail blotches, 10; scale rows, 23-23-19; infralabials, 9-9; supralabials, 9-9; preoculars, 1-2; total length, 677 mm.; tail length, 94 mm.

The presence of *R. l. tessellatus* in the state of Chihuahua was predicted by Smith and Taylor (1945).

Thamnophis cyrtopsis cyrtopsis (Kennicott). Coahuila: Two females from 3 mi. S and 8 mi. E Hechicero, Chihuahua (Nos. 33866-67). They were taken from a massive limestone outcrop in the desert. The following data were recorded: 19-19-17, 19-19-17 scale rows; 175, 169 ventrals; 72, 61 plus (tail damaged in 33867) caudals; 8-8, 8-7 supralabials; 10-10, 10-10 infralabials; 1-1, 1-1 preoculars; 3-3, 3-3 postoculars; total length, 554 mm., 237 mm.; tail length, 118 mm., 43 mm.

Thamnophis cyrtopsis cyclides Cope. Durango: A male, No. 33871 was taken 7 mi. SW Las Adjuntas. Scale rows number 19-19-17; ventrals, 160; caudals, 85; supralabials, 7-7; infralabials, 10-10; preoculars, 1-1; postoculars, 3-3; total length, 591 mm.; tail length, 160 mm.

Thamnophis eques megalops (Kennicott). Coahuila: Three males from 2 mi. SE Hechicero, Chihuahua (Nos. 33868-70). The specimens exhibit respectively the following variations: scale rows, 21-21-19, 21-21-17, 21-21-18; caudals, 69, 69, 76; ventrals, 157, 158, 161; supralabials, 8-8, 8-8, 8-8; infralabials, 9-9, 10-11, 10-10; preoculars, 1-1, 1-1, 1-1; postoculars, 3-3, 3-3, 4-5; total length, 239 mm., 397 mm., 681 mm.; tail length, 53 mm., 84 mm., 135 mm. These snakes were captured on a dry hillside in the foothills of the Sierra de los Hecheros. This is the first record for this subspecies for Coahuila.

Bothrops dunni (Hartweg and Oliver). Oaxaca: 10 mi. W and 2 mi. N Tehuantepec (No. 33812). It was taken at night.

Crotalus atrox Baird and Girard. Coahuila: 2 mi. SSE Castillón (No. 33851). It was captured in the evening as it attempted to escape beneath a clump of mesquite.

Crotalus molossus molossus Baird and Girard. Coahuila: 3 mi. S and 8 mi. E Hechicero, Chihuahua (Nos. 33849-50). These rattlesnakes were caught in separate clumps of *Agave* on a steep hillside.

Crotalus pricei pricei Van Denburgh. Durango: 7 mi. SW Las Adjuntas, at an elevation of 8,900 feet (No. 33852). The following data were recorded: Total length, 310 mm.; tail length, 39 mm.; scale rows, 21-19-16; ventrals, 156; caudals, 24; supralabials, 11-11; infralabials, 11-11; body blotches, 44; tail bars, 9.

This specimen extends the known range approximately 70 miles to the southwest of the southernmost record reported by Klauber (1952).

LITERATURE CITED

Burger, W. Leslie
1952. Notes on the Latin American skink, *Mabuya mabouya*. Copeia, 1952 (3):185-187.

Hamilton, Rodgers D.

1947. The range of *Pseudemys scripta gaigeae*. Copeia, 1947 (1): 65-66.

Hartweg, Norman

1938. *Kinosternon flavescens stejnegeri*, a new turtle from northern Mexico. Occ. Papers Mus. Zool. Univ. Michigan, 371:1-5.

Klauber, Laurence M.

1952. Taxonomic studies of the rattlesnakes of mainland Mexico. Bull. Zool. Soc. San Diego, 26:1-143, figs. 1-12.

Langebartel, David A., and Hobart M. Smith

1954. Summary of the Norris Collection of reptiles and amphibians from Sonora, Mexico. Herpetologica, 10 (part 2): 125-136.

Mittleman, M. B.

1940. Two new lizards of the genus *Uta*. Herpetologica, 2 (part 2):33-38, figs. 1-2.

1941. A critical synopsis of the Mexican lizards of the *Uta ornata* complex, and a description of a new species from Chihuahua. Jour. Washington Acad. Sci., 31:66-81.

1942. A summary of the iguanid genus *Urosaurus*. Bull. Mus. Comp. Zool., 91(2):104-181, pls. 1-16, figs. 1-11.

Peters, James A.

1951. Studies on the lizard *Holbrookia texana* (Troschel) with descriptions of two new subspecies. Occ. Papers Mus. Zool. Univ. Michigan, 537:1-20, 1 map, 2 tables.

Smith, Hobart M., and Edward H. Taylor

1945. An annotated checklist and key to the snakes of Mexico. Bull. U. S. Nat. Mus., 187:iv + 239 pp.

1950. An annotated checklist and key to the reptiles of Mexico exclusive of the snakes. Bull. U. S. Nat. Mus. 199:v + 253 pp.

Smith, Hobart M.

1935. Descriptions of new species of lizards from Mexico of the genus *Uta*, with notes on other Mexican species. Univ. Kansas Sci. Bull., 22(7):157-183, pl. 26.

1936. Two new subspecies of Mexican lizards of the genus *Sceloporus*. Copeia, 1936 (4):223-230.

1936. The lizards of the *torquatus* group of the genus *Sceloporus* Wiegmann, 1828. Univ. Kansas Sci. Bull., 24(21):539-693, pls. 47-55, figs. 1-25.

1947. Subspecies of the Sonoran toad (*Bufo compactilis* Wiegmann). Herpetologica, 4 (part 1):7-13.

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Hematological Studies on Salamanders in Relation to Their Ecology*

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Although considerable study has been made of various aspects of the blood of amphibians, the correlation of hematological data with their ecology has not been emphasized.

Various workers have reported the size and number of red blood cells of a few species of salamanders (Smith, 1925; Wintrobe, 1933; Jordan, 1938; Howell, 1950). A positive correlation between blood sugar level and activity of an organism has been noted for various groups of animals (Gray and Hall, 1930, marine teleosts; Kiermeir, 1939, fresh water fishes; Erlenbach, 1938, birds), but a comparative study of salamanders has not been reported in the literature. However, numerous field observations on the behavior and habitats of salamanders have been reported which furnish a good ecological basis for comparison (Reynolds and Black, 1936; Bishop, 1943; Hairston, 1949; Vernberg, 1952, 1953). The present investigation was undertaken to study in more detail the hematology of salamanders and to correlate any findings with the physiological adaptation of species to their habitats.

MATERIALS AND METHODS

Red blood cells were counted and measured of 12 species of salamanders. The animals studied, with one exception, represent two geographical areas: one group was from West Central Indiana, the other from the general area of Neal Creek, North Carolina. The species from Indiana were: *Ambystoma tigrinum tigrinum* (Green), *A. maculatum* (Shaw), *Eurycea bislineata bislineata* (Green), *E. lucifuga* (Rafinesque), *Plethodon cinereus cinereus* (Green), *P. dorsalis* (Cope), and *P. glutinosus glutinosus* (Green). Those from North Carolina were: *Desmognathus ochrophaeus carolinensis* (Dunn), *D. phoca* (Matthes), *D. quadramaculatus quadramaculatus* (Holbrook), and *Gyrinophilus danielsi danielsi* (Blatchley). The *Necturus* used came from Wisconsin.

The number of red blood cells was determined by standard techniques. In order to insure more nearly accurate results, five individual counts were made from each pipette and then the average was taken as the final count. Measurements of red blood cell size were made by means of a Spencer micrometer, using blood smears stained with Wright's stain. Widths and lengths of 500 cells were obtained from blood samples from five individuals.

Blood sugar levels of six species of salamanders were determined by the Folin-Wu micro method. These animals were: *Ambystoma tigrinum, Ambystoma maculatum, Eurycea bislineata, Necturus maculosus, Plethodon cinereus, Plethodon glutinosus.* Animals had been kept in a good state of nutrition at room temperature for approximately one week before being sacrificed.

The blood for both red blood cell studies and blood sugar determinations was collected directly from the heart of the animal except in the case of *Necturus,* where it was sampled from an efferent branchial artery.

* A portion of this work was done at Purdue University, Lafayette, Indiana.

Preparatory to collecting the blood, the brain of the animal was crushed by forceps and the heart was exposed. Because of the small body size of *Plethodon cinereus* and *Eurycea bislineata,* it was necessary to use combined blood samples for the determination of their blood sugar level.

RESULTS AND DISCUSSION

Red blood cell size of 12 species of salamanders are given in Table 1. When the length (L) and the width (W) of a cell are multiplied, it is possible to compare size. If the length is divided by the width, a comparison of shape is possible.

TABLE I. Comparison of Red Blood Cell Sizes in Salamanders

Species	Length in Micra	Width in Micra	L x W	L/W
Desmognathus o. carolinensis	30.697 ± 0.121	12.701 ± 0.070	389.88	2.417
Desmognathus monticola	29.426 ± 0.164	14.861 ± 0.092	437.30	1.980
Desmognathus q. quadramaculatus	31.968 ± 0.175	16.655 ± 0.100	532.43	1.919
Plethodon c. cinereus	30.688 ± 0.138	16.345 ± 0.084	501.60	1.878
Plethodon c. dorsalis	32.193 ± 0.194	17.444 ± 0.122	561.58	1.845
Plethodon glutinosus	33.440 ± 0.199	20.195 ± 0.103	675.32	1.656
Eurycea b. bislineata	30.023 ± 0.119	14.798 ± 0.083	444.28	2.029
Eurycea lucifuga	36.400 ± 0.154	21.980 ± 0.098	800.07	1.656
Ambystoma tigrinum	34.530 ± 0.192	19.020 ± 0.154	656.76	1.815
Ambystoma maculatum	37.940 ± 0.369	23.910 ± 0.133	907.15	1.587
Gyrinophilus d. danielsi	37.446 ± 0.319	21.004 ± 0.176	786.52	1.783
Necturus m. maculosus	40.500 ± 0.160	28.213 ± 0.154	1142.63	1.439

Necturus has the largest sized cell and *D. o. carolinensis,* the smallest. In respect to cell shape, *D. o. carolinensis* has the most nearly ellipsoidal cell and *Necturus* has the most nearly circular cell. When comparing different species, it can be noted that members of the same genus do not always have similar sized cells. In *Desmognathus,* cells of *quadramaculatus* were 1.4 times larger than *ochrophaeus,* and in *Eurycea, lucifuga* cells were 1.8 times larger than those of *bislineata.* Although there is overlapping of species of various genera, the red blood cell size of all three species of *Desmognathus* studied is smaller than either species of *Ambystoma.* A difference is also noted in the red blood cell size of two species, *P. cinereus* and *P. dorsalis.*

In general, results of other workers are similar to those obtained in the present study for any species in common. Jordan (1938) reported an average red blood cell size of 32.0 x 13.0 micra for *P. cinereus,* the figures cited in Table 1 are 30.7 x 16.3 micra. Howell (1950), working with *D. q. quadramaculatus,* found the red blood cell size to be 30.58 x 17.00 micra; the figures obtained in the present study are 31.97 x 16.66.

A general correlation between red blood cell size and body weight seems apparent. The largest species, *Necturus,* has the largest red blood cell, while *D. o. carolinensis,* one of the smallest species, has the smallest red blood cell. In the genus *Plethodon, glutinosus* is larger than *cinereus* and this species also has larger red blood cells. A similar relationship is found in the genus *Desmognathus.* However, an exception to this generalization is noted in the genus *Ambystoma,* where the larger sized species, *tigrinum,* has smaller red blood cells than *maculatum.*

When comparing species, a correlation is noted between activity and red blood cell size. In the genus *Plethodon,* Vernberg (1954) has shown that *cinereus* not only responds more quickly than *glutinosus* to certain environmental factors but has a higher metabolic rate. Evans (1939)

determined the oxygen consumption of several species of plethodontid salamanders and correlated her findings with their activity. Species in common, which she regarded as most active, have smaller red blood cells than species with lower Qo_2 values and larger red blood cells. These results are in accord with the findings of Smith (1925), who worked with Amphibia other than semi-aquatic and terrestrial salamanders. No clear distinction can be made, however, between animals occupying different habitats when based on red blood cell size, with the possible exception that animals which are entirely aquatic have larger red blood cells.

An inverse relationship is noted when comparing number and size of red blood cells. The species having the largest sized cells have the fewest number of red blood cells (Table 2). However, a marked exception to this generalization is observed in *E. lucifuga* which has not only a greater number of red blood cells than *E. bislineata,* but also has larger sized cells. Although only two determinations were made on *E. lucifuga* because of the scarcity of this species, there is no overlapping of results with those of *E. bislineata.*

TABLE II. The Number of Red Blood Cells of Several Species of Salamanders

Species	Number of Determinations	Number of cells per mm.^{3} Low	High	Average
Desmognathus monticola	6	165,600	234,000	196,650
Desmognathus o. carolinensis	5	149,500	191,400	169,050
Desmognathus q. quadramaculatus	5	95,300	180,000	130,500
Plethodon cinereus	10	24,276	177,600	91,078
Plethodon glutinosus	9	30,355	99,355	55,700
Eurycea bislineata	10	60,000	110,000	79,568
Eurycea lucifuga	2	155,500	204,000	177,750
Gyrinophilus d. danielsi	4	72,500	108,000	88,000
Ambystoma tigrinum	10	71,050	100,540	81,424
Ambystoma maculatum	9	43,550	65,430	52,520
Necturus maculosus	19	7,000	63,000	27,912

What appears to be a diurnal change in the number of red blood cells of *Necturus* is noted. In five specimens sampled both at 9:00 A.M. and 9:00 P.M., it is observed that the evening counts are higher in four of the specimens, while in the remaining specimen the count is unchanged. An increase in red blood cells could be correlated with the nocturnal activity habits of this animal. However, this problem needs further investigation before being statistically analyzed.

Results of blood sugar determinations of six species of salamanders are given in Table 3. It is noted that most of the values are near the

TABLE III. The Blood Sugar Level of Several Species of Salamanders

Species	Number of Determinations	Blood sugar level in mg% Low	High	Average
Ambystoma tigrinum	10	63.3	86.0	74.5
Ambystoma maculatum	9	26.0	41.0	31.7
Eurycea bislineata	2	63.3	70.3	66.8
Plethodon cinereus	2	55.0	63.3	59.1
Plethodon glutinosus	5	45.0	55.0	50.2
Necturus maculosus	8	30.0	83.0	42.1

average but an occasional diverse reading is obtained. As was stated previously, a correlation between blood sugar level and activity and habits of some groups of animals has been noted. This general correlation appears to apply to salamanders as well. The aggressive *A. tigrinum* has a higher blood sugar level than the relatively lethargic *A. maculatum*. Both *Necturus* and *A. maculatum* have the lowest blood sugar level and the largest red blood cell size of the species reported in this study.

SUMMARY

The size and number of red blood cells of 12 species of salamanders was determined. In addition, blood sugar level determinations of some of these species were made. Results indicate that physiological adaptation of species has occurred, and that salamanders considered to be most active have a higher blood sugar level and smaller but more numerous red blood cells.

LITERATURE CITED

Bishop, S. C.
1943. Handbook of Salamanders. 555 pp. Comstock Publishing Co., Inc.

Erlenbach, F.
1938. Experimentelle untersuchungen über den Blutzucker bei Vogelin. Z. vergl. Physiol., *26:* 121-161.

Evans, G.
1939. Factors influencing the oxygen consumption of several species of Plethodontid salamanders in aerial and aquatic media. Ecology, 20: 74-95.

Gray, L. E., and F. G. Hall
1930. Blood sugar and activity in fishes with notes on the action of insulin. Biol. Bull., *58:* 217-223.

Hairston, N. G.
1949. The local distribution and ecology of the Plethodontid salamanders of the southern Appalachians. Ecol. Monographs, *19:* 47-73.

Howell, Thelma
1950. Red blood cell size in the male frog, *Rana catesbeiana* Shaw. J. Tenn. Acad. Sci., *25:* 237-241.

Jordan, H. E.
1938. Downey's Handbook of Hematology. Vol. 2 Comparative Hematology. New York, Hoeber. See pp. 703-862.

Kiermeir, A.
1939. Uber der Blutzucker der Susswasserfische. Z. vergl. Physiol., 27: 460-491.

Reynolds, A. E., and E. G. Black
1936. The Salamanders of Putnam County. Proc. Ind. Acad. Sci., *45:* 287-294.

Smith, H. M.
1925. Cell size and metabolic activity in Amphibia. Biol. Bull., *48:* 347-378.

Vernberg F. J.
1952. Notes on some salamanders of west central Indiana. Copeia, *1952:* 278.

1953. Hibernation studies of two species of salamanders, *Plethodon cinereus cinereus* and *Eurycea bislineata bislineata.* Ecology, *34:* 55-62.

1954. Correlation of physiological and behavior indices of activity in the study of *Plethodon cinereus* (Green) and *Plethodon glutinosus* (Green). Am. Midl. Nat., in press.

Wintrobe, M. M.

1933. Variations in the size and hemoglobin content of erythrocytes in the blood of various vertebrates. Folia Haematol., *51:* 32-36.

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Glass Lizards (*Ophisaurus*) in the Pleistocene and Pliocene of Florida

By W. AUFFENBURG

While engaged in obtaining material for a comprehensive study of the fossil snakes of Florida numerous lizard remains have been found. Included in these collections are vertebrae of the genus *Ophisaurus,* fossil remains of which have never been reported in the New World.

Since glass lizards are rather widespread throughout a large portion of eastern and central North America in recent times, it is entirely possible that an examination of fossiliferous late Tertiary deposits in other states will disclose this characteristic genus. In Florida it has been found in localities where it has been collected utilizing techniques very similar to those outlined by Hibbard (1949).

McConkey (1954) has shown that there are three extant species of *Ophisaurus* inhabiting North America, as based on external structures. An examination of the osteological characters in this genus also indicates three well-defined groups, representing *Ophisaurus ventralis, O. compressus* and *O. attenuatus.* McConkey (*ibid.*) has already indicated the differences that exist in the number of teeth and the relative length of the skull in the three species. In these characters *compressus* is closer to *attenuatus.* Apparently the lack of palatine teeth, observed in three specimens of *attenuatus,* is a fairly good diagnostic character of this species. These teeth are quite prominent in five specimens of *ventralis* and two *compressus.*

The vertebrae of these three species are also different. In the skeletons of *ventralis* and *compressus* available to me the five most anterior vertebrae are provided with single well-developed hypapophyses. Only three vertebrae are provided with these processes in the available skeletons of *attenuatus.* In *ventralis* the angle of the posterior edge of the neural spine varies from 74° to 84°. In *compressus* it varies from 78° to 91°. In *attenuatus* it ranges from 56° to 68°. Thus, the vertebral elements of *ventralis* and *compressus* are similar, whereas those of *attenuatus* are quite different.

Since none of the Pleistocene vertebrae have the posterior edge of the neural spine at an angle of less than 70° it is highly probable that they represent only *compressus* and/or *ventralis*, and not *attenuatus*. The ratio obtained by dividing the length of the centrum by its width can be utilized as a diagnostic character to separate *compressus* and *ventralis*, since these ratios differ considerably in both species. Comparison of the ratios of fossil and vertebrae of fossil and recent specimens reveals a high probability that both *ventralis* and *compressus* are represented by the Pleistocene remains (fig. 1).

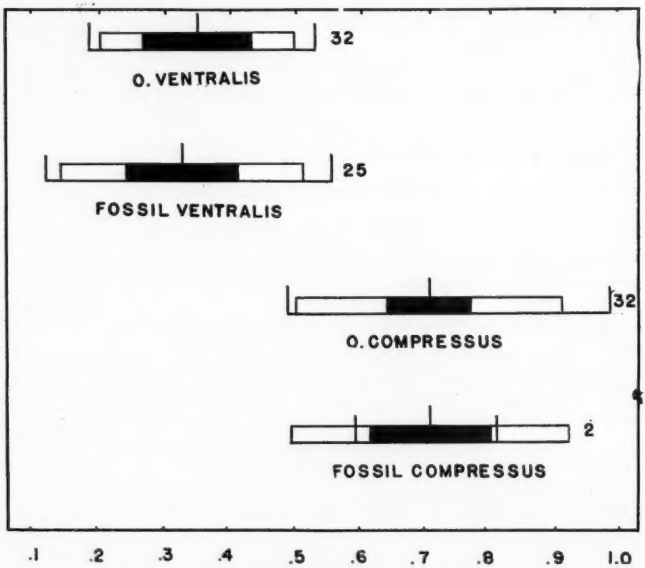

FIGURE 1. The ratio of the length of the centrum divided by its width in both modern and fossil vertebrae of *Ophisaurus*. The mean and total range is indicated by vertical lines; solid rectangles equal one standard error of the mean; hollow rectangles equal two standard deviations; the total number of vertebrae measured are indicated to the right of each graph.

MATERIAL EXAMINED

The recent comparative material consists of five skeletons of *ventralis*, three *attenuatus* and two *compressus*. All of the fossil remains have been deposited in the University of Florida collections.

Ophisaurus ventralis Linnaeus

Fossil remains of this species have been obtained at the following Pleistocene localities:

(1) Dixie Lime Products Co., limestone quarry, approximately one mile S. Reddick, Marion Co., Fla. This locality contains many extinct genera of mammals, such as *Megalonyx, Dasypus, Holmesina, Mammut, Equus, Tanupolama,* etc. (Gut 1938, with many recent additions, personal communication). Brodkorb (1952) has described a new rail (*Laterallus guti*) from this deposit. The *O. ventralis* material includes twenty-three thoracic (UF 5052-5068, 5070-5073, 5641-2) and five caudal vertebrae (UF 5059).

(2) Haile, Alachua Co., Fla., limestone quarry number VII, locality A (SE ¼ Sec. 24, T 9 S, R 18 E). This locality has been discovered fairly recently and most of the mammalian remains are still unidentified. However, the presence of *Equus, Holmesina* and *Dasypus* are indicators of its Pleistocene age. The birds of a Pleistocene sinkhole approximately one-quarter mile west (Haile # 1, Loc. A; SW ¼ Sec. 24) have been discussed by Brodkorb (1953, 1954), while Tihen (1952) has reported *Rana grylio* from the same deposit. Only four vertebrae of *Ophisaurus ventralis* are known from this locality (UF 5078-9, UF 5098-9).

(3) Haile, Alachua County, Fla., limestone quarry number II, locality B (NW ¼ Sec. 25, T 9 S, R 18 E). This deposit, of very small extent, was apparently a Pleistocene cave. The only extinct genera of mammals known from this locality are represented by a tooth of *Equus* sp., and plates of *Dasypus bellus.* One thoracic vertebra, tentatively assigned to *O. ventralis,* is available (UF 5077). The ratio of the length of the centrum divided by its width is 1.38, well within the normal range of *ventralis.*

(4) Haile, Alachua County, Fla., number VI, locality A (SW ¼ Sec. 24, T 9 S, R 18 E). This deposit, of very small extent, apparently represents a fluviatile or sink-hole deposit. The presence of *Hipparion* and *Pseudomys caelata* in the deposit suggests a Pliocene fauna. In addition, many reptiles and amphibians collected at this deposit represent different species than those found in deposits known to be Pleistocene or Micoene in age. There is no geological or faunal evidence of mixture to indicate that the locality represents two epochs. The fossil glass lizard collected at the deposit is represented by one fragmental vertebra (UF 9974), which although clearly referable to this genus, is tentatively allocated to *O. ventralis.* Its vertebral properties place it in, or close to *ventralis* rather than *compressus.*

Ophisaurus compressus Cope

This species is known from one locality so far. This is Haile, Alachua Co., Fla., limestone quarry number II, locality B. The length of the centrum divided by its width in the two available specimens (UF 5075-6) is 1.58 and 1.84, falling well within the normal range of variation for modern *compressus* (fig. 1).

There is no evidence to indicate that the Pleistocene members of this genus attained a greater size than the modern representatives of this group, such as Brattstrom (1953) has indicated for *Cnemidophorus tigris* from Rancho La Brea, California.

The fact that *Ophisaurus compressus* has been found in the Pleisto-

cene of Alachua County is of considerable interest, since McConkey (1954) shows no records from this county. The usual habitat of *compressus* is a rosemary scrub association, either coastal or inland. The immediate area of the fossil locality at the present time is high pine-turkey oak, which is the normal habitat of *attenuatus* (McConkey, *ibid*). The presence of *compressus* in this area during Pleistocene time might indicate that this locality was in, or very near a scrub association, which through an associational succession has developed into high pine-turkey oak.

The known fossil material of *Ophisaurus* does not necessarily invalidate, or completely support McConkey's postulated origins for the modern species of this genus. However, if it is subsequently shown that the deposit at Haile II, B is earlier than the Sangamon Interglacial or Illinoian Glacial periods both *ventralis* and *compressus* must have become differentiated during an earlier period, since both species are clearly separable in this deposit. The presence of *ventralis*, or a species close to it, in the Pliocene of Florida is highly interesting; but until more material is collected and examined the importance of this discovery as it relates to the evolution and dispersion of the group remains somewhat obscure. On the basis of present information it is highly probable that, (1) at least two groups, representing *attenuatus* and *ventralis*, were established before or during the Pliocene, or, (2) the ancestral form of the North American glass snakes is very similar to *O. ventralis*, or identical with it.

Further collecting may well show that *O. attenuatus* also inhabited Florida during the Pleistocene, as has been postulated by McConkey (*ibid*).

LITERATURE CITED

Brattstrom, B. H.
1953. The amphibians and reptiles from Rancho La Brea. Trans. San Diego Soc. Nat. Hist. 11 (14): 365-393.

Brodkorb, P.
1952. A new rail from the Pleistocene of Florida. Wilson Bull. 64 (2): 80-82.
1953. Pleistocene birds from Haile, Florida. Wilson Bull. 65 (1): 49-50.
1954. Another new rail from the Pleistocene of Florida. Condor 56 (2): 103-104.

Gut, H. J.
1938. Additions to the recorded Pleistocene mammals from Ocala, Florida. Proc. Fla. Acad. Sci. 3: 54-55.

Hibbard, C. W.
1949. Techniques of collecting micro-vertebrate fossils. Contrib. Mus. Pal., Univ. Mich. 8 (2): 7-19.

McConkey, E. H.
1954. A systematic study of the North American lizards of the genus *Ophisaurus*. Amer. Midl. Nat. 51 (1): 133-174.

Tihen, J.
1951. *Rana grylio* from the Pleistocene of Florida. Herp. 8 (3): 107.

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Adrenal Enlargement and Its Significance in the Hognose Snakes (*Heterodon*)

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The genus *Heterodon* includes snakes with many well-known, bizarre habits and structures. It is so strange in musculature (Mosauer, 1935) as to suggest that it might even be assigned subfamily distinction from other North American snakes. Be that as it may, we have become aware of yet another feature apparently unique to this genus and related genera: a remarkably enlarged adrenal gland. So far as we know, this has not previously been recorded in the literature. We are indebted to our colleagues, Dr. B. Vincent Hall for the original observation of adrenal enlargement in *Heterodon*, Mr. Harold Kerster for interpretive assistance, and Drs. Fred and Virgene Kavanagh for helpful criticisms.

The adrenal glands of snakes are roughly elongate, slender, usually pinkish (in preserved specimens) structures found anterior to the kidneys in the mesenteries associated with the gonads. In females they are to be found between the ovary and oviduct, whereas in males they are closely adherent to the vas deferens adjacent to the posterior end of the testis. They are of much the same appearance and location in all snakes examined and are not, as described by Bourne (1936), "streaks of cells along the lobes of the attenuated kidney." Apparently Bourne observed some structure other than the adrenal gland in the "boa constrictor" examined. The glands measure roughly 6 mm. to 50 mm. in length in snakes measuring between 395 and 1200 mm. in body length. Their width varies from about 1 to 5 mm., and their thickness is approximately 0.5 to 2 mm. The shape of the glands varies greatly and the right tends to be larger than the left.

Gross comparison clearly reveals a wide disparity between *Heterodon* and other North American snakes in the relative size of adrenal glands. Expression of the difference in precise terms is unfortunately not simple. Linear measurements are not adequate because of irregularity of shape. Direct volumetric measurements were not feasible with the equipment at hand because of the very small sizes involved. We considered weight measurements to involve the fewest procedural errors, contrasting total adrenal weight (right and left glands combined) with total body weight. The glands were weighted after cleaning as much connective tissue from them as possible, and after quickly blotting excess fluid from their surfaces. The bodies of the snakes were similarly drained of preservative, blotted and weighed. The differences between the various snakes tested, as revealed by the procedures adopted, are of such magnitude as to be reasonably regarded as offsetting the necessarily unrefined techniques.

In summary of the results of our measurements (Table 1), we found that the body weight varied from 320 to 666 times the combined adrenal weight in the 5 *Heterodon platyrhinos* analyzed, and 1566 to 1670 times in 2 *H. nasicus*. One species, *Xenodon merremi*, matched *H. nasicus* with 1670. On the other hand, the body weight in 20 specimens of 15 other species of snakes varied from 1913 to 8825 times the combined adrenal weight; published figures for 85 specimens of 3 other species fall well within this range. The maximum percentage is about

one-third of the minimum found in *H. platyrhinos,* and at least a sixth less than in *H. nasicus* or *X. merremi.* The maximum, aside from *Xenodon,* occurs in *Thamnophis,* followed by *Sistrurus.*

Other peculiarities of *Heterodon* and *Xenodon* to which attention should be called in connection with adrenal size are those that adapt these genera so remarkably to a bufonid diet. The highly mobile maxillae (Boulenger, 1915; Anthony and Serra, 1951), the enlarged rear maxillary teeth (which aid not only in deglutition of a large object but also in deflating it), the exceptionally broad head, expansive gape and the relatively thick body, all contribute to the extraordinary adaptation to subsistence exclusively upon toads. Other Xenodontine genera of comparable build include *Lysorhophis* and *Lioheterodon,* but whether they possess enlarged adrenals or actually prey extensively on toads is unknown to us. *Xenodon* is definitely known (Santos, 1942) to feed extensively upon toads, and Brazil and Vellard (1926) have shown it is physiologically, as well as morphologically, adapted for such a diet. In *Heterodon* the importance of toads in the diet is well authenticated. Surface (1906) reported that 75% of the food of *H. platyrhinos* consists of toads; Uhler *et al* (1939) gave a somewhat lower figure (40%). Munro (1949) verified that *H. nasicus* readily feeds upon toads. Records and our own observations show that in captivity most specimens of *Heterodon* seldom feed upon anything but toads, although stomach analyses reveal a variety of other vertebrates eaten under natural conditions; even in captivity some specimens will eat other vertebrates. The suggestion (Perkins in Munro, 1949) seems plausible that snakes from areas where toads are common readily eat them, whereas specimens from areas where the toads do not occur refuse to eat them. This is food imprinting, of astonishingly common occurrence among reptiles.

The only other North American snakes that commonly feed upon toads are, so far as we are aware, certain garter snakes of the genus *Thamnophis.* In *T. ordinatus* as much as 16% (Surface, 1906) to 25% (Uhler *et al.* 1939) of the diet may be toads. Certain water snakes of the genus *Natrix* (*N. septemvittata, N. sipedon*), and perhaps some members of the genera *Coluber, Diadophis* and *Rhadinaea* are recorded as having eaten toads. For none of these species do toads form as large a part of the diet as they do for *Heterodon.* Furthermore, these snakes appear to be limited to immature toads by their relatively narrower head and body, and by the absence of a deflating mechanism.

The most important adaptation to bufophagy, however, would seem to be none of the mechanical features that aid in deglutition but rather the physiological resistance to the powerful poisons occurring in toad skins. So powerful are these poisons that scarcely any vertebrate can prey upon adult toads at least of medium sized or large species. Dogs have been killed by mouthing *B. alvarius* (Musgrave and Cochran 1930); at least one record is available of a human death caused by eating *B. marinus* mistaken for edible frogs (Herpetologica, in press); Tschambers (1948) records the death of a normally frog-eating snake (*Dinodon semicarinatum*) subsequent to the acceptance of a small toad (*B. americanus*); Brazil and Vellard (1926) record the death of two snakes (*Crotalus durissus, Lachesis*) simply forced to bite toads (*B. marinus*); and the latter authors also present much experimental data showing

the extreme susceptibility of numerous kinds of vertebrates to the poison of *B. marinus*. In fact, the only animals found by Brazil and Vellard to exhibit marked resistance were toads themselves and *Xenodon*. Unfortunately they tested no North American species and no genera related to *Heterodon* (except for *Xenodon*).

The amount of secretion in the skin of a toad, as indicated by the works of Chen (1933 *et al.*) varies considerably according to species and size of specimen, but in adult stages approximates 0.5% of the total weight. Thus a 50 mg. toad (an average adult American toad) would be expected to possess about 250 mg. of secretion. About half is located in the parotoid glands. To be sure, an interspecific variation in toxicity of parotoid secretion is to be expected, but as an example the figures given by Brazil and Vellard (1926; also cited in Maass, 1937) for *B. marinus* are of great value. These investigators found that the minimum lethal oral dose of parotoid secretion from *B. marinus* varies for most snakes from less than one to about 25 mg./kg. body weight. *Xenodon* was the only snake genus exceeding this limit; recovery ensued after receiving 1000 mg., and the lethal dose was never determined. A *Xenodon* that was force-fed a *Bufo crucifer* regurgitated it after two hours, and when the toad was forced down again it was regurgitated in five minutes. Yet a transitory, slight paralysis was the only visible effect upon the snake. Thus the average-sized toad may be regarded as possessing, in reference to most snakes, at least 5 lethal doses of poison in the parotoid secretion alone, and perhaps still more in secretions from skin glands other than the parotoids. *Xenodon* and *Heterodon* are clearly immune to these effects. Toads are from 50 to 3000 times as resistant to their own skin poisons as is the average snake or mammal, their MLD being about 3 mg/g body weight (Brazil and Vellard, 1926).

The parotoid gland secretions are not identical with those of other skin glands. Three groups of potentially lethal substances exist in toad venom. One is epinephrine, apparently occurring only in the parotoid secretion. Both of the other groups occur in all glands. Bufotenine is a complex which powerfully stimulates secretion of epinephrine by the adrenal glands, and has much the same action as epinephrine, but is unrelated to epinephrine chemically. Its action may be lumped with that of epinephrine itself since the physiological hazards to the predator are the same for each. References hereinafter to the effects of ingested epinephrine embraces also the stimulatory role of bufotenine. The third group includes bufotoxin and bufagin (following the terminologies of Chen and Chen, 1934 *et al*), compounds having a powerful digitalis-like effect. The digitaloid compounds and epinephrine are of lethal potential to vertebrates, even in minute concentrations.

The most prominent, and probably the sole lethal action of epinephrine is acceleration and augmentation of heart beat. Lethal doses in snakes have not been determined, but they are assumed to be comparable to those of other animals. Even toads are highly sensitive to their own skin-secreted epinephrine (Abel and Macht). However, the proportion of lethal doses of epinephrine to those of the digitaloids in toad venom is so small, relatively speaking, that animals succumb to the latter rather than to the epinephrine. Only in those animals having great resistance to the digitaloids, or accidentally ingesting unusually large quantities of

the whole venom, would epinephrine likely be lethal. A death caused by epinephrine should always follow almost immediately upon ingestion of the poison, whereas death from the digitaloids might be almost immediate or delayed as long as 5 days depending upon its concentration (Brazil and Vellard). Despite the proportionally small amounts of epinephrine as compared with the digitaloids in the skin secretion, the actual amount of epinephrine present in the parotoid glands is astonishing. Extrapolating from amounts recorded for *Bufo regularis, B. arenarum* and *B. marinus* (Chen and Chen, 1933, 1934), a toad the size of a large *B. americanus* should possess about as much in its parotoid glands as man does in his adrenal glands (8-9 mg.). Five tropical and Chinese species have been shown to possess epinephrine in the gland secretion, although the actual proportion has been determined only for the three species cited above. Curiously, epinephrine has not been recorded in the secretions of any of the 5 North American species analyzed (*B. valliceps, B. fowleri, B. americanus, B. alvarius, B. quercicus*) nor in *B. v. viridis* or *B. b. bufo* (although it is recorded in *B. b. gargarizans!*), although bufotenine has; as stated previously the end result is essentially the same whether epinephrine or bufotenine is ingested by a predator.

The most prominent and probably the sole lethal effect of the digitaloid compounds is slowing of the heart beat, reversing the effect of the epinephrine. One might largely counteract the other if their effects were not staggered. Taken orally, epinephrine is quickly absorbed through the buccal and pharyngeal linings, and its effects quickly dissipate if they are not lethal. The digitaloid compounds are absorbed through the stomach wall, and their effects mask those of epinephrine. Lethal doses in snakes have not been determined, although it is presumed that the MLD established for the whole venom (Brazil and Vellard) actually is based upon the digitaloids since they are the most potent venom factor. The poison is known to be highly toxic to most vertebrates. In tested mammals the MLD varies from 0.76 mg/kg to 5 mg/kg (Abel and Macht, 1912). Some vertebrates, on the contrary, have developed a certain degree of resistance to the poison, as for example toads themselves (Abel and Macht, 1912) and, of necessity, all bufophagous animals. It is, of course, possible that a resistance to the poison could be built up individually by a gradually increasing dosage of the poison. Indeed, snakes as a matter of course do take graduated doses (if any), as with their growth the size of acceptable prey increases. On the contrary, Brazil and Vellard (1926) have shown that small doses spread out over as much as 15 days, given at 3-4 day intervals (long enough to allow for apparently complete recovery from each) resulted in death (in both the rabbit and toad, *B. marinus*) as the total intake reached the approximate level of a single lethal dose (about .058 mg/g in the rabbit).

It is our hypothesis that the physiological adjustment to a diet of toads, especially well developed in *Heterodon and Xenodon,* is correlated with enlargement of the adrenal glands, and that the enlarged adrenals evolved in conjunction with adaptation to bufophagy. The adaptation may not be necessary at the present time for a given particular species of toad these snakes may eat, but we suggest that bufophagy and enlarged adrenals at least originally evolved conjointly. *Thamnophis,* with the largest adrenal glands next to the preceding genera, is recorded as feeding upon

toads more frequently than any other North American snakes, save *Heterodon*. It is to be assumed that garter snakes are not, however, exposed to such large quantities of skin secretion as are the hognose snakes, since the former feed primarily upon small toads having poorly developed skin glands. The rudimentary development of skin glands in young toads is common knowledge; the conformation of the glands is of great taxonomic importance in adults, but the young are virtually unidentifiable because the glands are poorly or not at all developed. Thus it may be assumed that snakes feeding upon young toads would be relatively free from the danger of exposure to excessive quantities of epinephrine; the lesser enlargement of the adrenal glands of garter snakes thus would appear to be correlated not so much with an infrequency of feeding upon toads, but with selection of immature, less toxic individuals. It may be assumed that other snakes feeding occasionally upon toads also select young ones, as they presumably lack the resistance to excessive doses of epinephrine that would be indicated by an enlarged adrenal gland.

An unexpected utilization of toads as food by *Sistrurus* is suggested by its unusually large adrenals. It is doubtful that all species of *Natrix* eat toads; perhaps members of the *grahamiae* group are adapted to bufophagy more than others.

The exact function of the adrenals in performance of their protective role in bufophagy is not yet experimentally assured, but two seem possible, and one is a theoretical certainty.

For one, a bufophagous animal must be resistant to both epinephrine and digitaloid compounds. Resistance to large doses of epinephrine means, presumably, an increase in tolerance of body cells generally, especially nervous tissues, to the drug. Yet since epinephrine is essential to the normal function of the body, production by the adrenals of unusually large quantities of epinephrine would be necessary to overcome the unusually high resistance to it acquired by bodily tissues as an adaptation to ingested (or stimulated secretion of) epinephrine. Thus, on this basis alone, an enlargement of the adrenal glands may be regarded as a virtually necessary adjunct of well-developed bufophagy. The experiments reported by Edgren (1955) show that indeed a fantastic resistance to epinephrine does exist in *Heterodon;* surely an enlargement of the adrenals is to be expected in order to produce the quantities of epinephrine necessary in the normal functioning of these animals. Indeed, Hartman and Brownell (1949:35) state that ". . . it seems reasonable to assume that adrenal size is an indicator of adrenal activity."

The basis of resistance to the digitaloid component of toad venoms is unknown, although cardiac tissue is of course the primary locus of resistance (Chen and Chen, 1933). It is possible that the interrenal secretions play a role in this connection, and if so the increase in size or abundance of interrenal cells would contribute further to the size of the adrenal glands.

The histological structure of the adrenal gland in several genera of snakes has been described (*e. g.* Junqueira, 1944), but whether the abundance of suprarenal tissue relative to interrenal tissue is different in bufophagous genera as compared with other genera is unknown. In at least one snake *(Bothrops jararaca)* the proportional adrenalin content is

about the same as in mammals (0.5-2.5 mg/g adrenal tissue, Valle and Porto, 1944-5).

The hypothesis here proposed concerning the significance of adrenal enlargement in *Heterodon* is, we realize, largely inferential. It is diametrically opposed to the inference of Chen and Chen (1934), who conclude that "the toad does not appear to use its poisonous secretions for either self-defense or body functions". Establishment of significance upon secure grounds will require much experiment and observation. Further researches are in progress.

TABLE I.

Total Adrenal and Total Body Weights in Some North American Snakes *

Species	Body Weight (gms.)	Adrenal Weight (gms.)	BW/AW
Heterodon platyrhinos platyrhinos	171.0	0.389	440
" " "	95.2	0.143	666
" " "	76.0	0.123	618
" " "	75.0	0.203	320
" " "	57.3	0.122	470
Heterodon nasicus nasicus	59.5	0.038	1566
" " "	54.2	0.046	1670
Xenodon merremi	83.5	0.05	1670
Thamnophis ordinatus	199.0	0.104	1913
" "	58.5	0.020	2925
" "	42.0	0.019	2211
" "	35.8	0.014	2557
Thamnophis marcianus nigrilateris	123.0	0.039	3154
" " "	82.0	0.038	2158
Sistrurus catenatus catenatus	166.5	0.057	2921
Natrix septemvittata	113.0	0.035	3229
" "	99.5	0.023	4326
Natrix sipedon sipedon	187.0	0.036	5194
Elaphe laeta laeta	59.8	0.017	3518
Boa constrictor constrictor	74.0	0.019	3895
Coluber constrictor flaviventris	92.5	0.020	4625
Ancistrodon piscivorus leucostoma	93.0	0.020	4650
Ancistrodon contortrix mokeson	112.0	0.020	5600
Micrurus fulvius tenere	78.0	0.016	4875
Liodytes alleni	86.0	0.016	5375
Pituophis melanoleucus deserticola	486.5	0.079	6158
Lampropeltis calligaster	214.5	0.026	8250
Crotalus viridus abyssus	141.2	0.016	8825

* The figures for non-xenodontine snakes are in close agreement with those obtained by other authors for other snakes. Hartman and Brownell (1949:37) cite percentages that can be transposed to BW/AW figures to compare with the data here given, as follows: *Tropidonotus natrix*, 2000; *Boa constrictor*, 6250; *Dryophylax* and *Tomodon* (lumped because insignificantly different) males (30) 3049 (av.), non-pregnant females (35) 3096 (av.), pregnant females (19) 2500 (av.).

Even if our hypothesis is correct, the extent to which enlargement of adrenals in snakes is environmentally labile is conjectural. The enlargement observed in xenodontine snakes may be genetically unique and fixed, not subject to individual variation according to extent of practice of bufophagy. The xenodontine enlargement may on the other hand be genetically unique but consist merely of the *capacity* to become enlarged in any individual in accordance with the extent to which bufophagy is practiced. It is even possible that the genetic capacity for the adrenals to become enlarged is not unique to xenodontines, and that the adrenals in many if not all snakes may become enlarged if the doses of toad poison are gradually increased. A convincing case cannot be made as yet for any one of these three alternatives.

Conclusions. Enlargement of the adrenal glands, especially evident in *Heterodon*, but true to a lesser degree in some other ("xenodontine") snakes as well, is presumed to be correlated with ingestion of excessively large quantities of skin secretions of toads, a dietary staple. Extent of adrenal enlargement and extent of bufophagy seem to be directly correlated in snakes. Snakes eating toads of moderate or large size must be resistant not only to large doses of epinephrine but also to even larger doses of digtaloid compounds. At least some and perhaps all xenodontine snakes exhibit extreme adaptation to bufophagy. Extent of genetic fixation of adrenal size is unknown.

BIBLIOGRAPHY

Abel, John J., and David I. Macht.

1912. Two crystalline pharmological agents obtained from the tropical toad, *Bufo agua.* Jour. Pharmacol Exp. Therap., 3: 319-377.

Anthony, J. and R. G. Serra.

1951. Anatomie de l'appareil de la morsure chez *Xenodon merremii* B., serpent aglyphe de l'Amerique tropicale. Arg. Mus. Nac., 42: 21-47, figs. 1-15.

Boulenger, E. G.

1915. On a colubrid snake *(Xenodon)* with a vertically movable maxillary bone. Proc. Zool. Soc. London, 1915: 83-85.

Bourne, G.

1936. The phylogeny of the adrenal gland. Amer. Nat. 70: 159-178.

Brazil, Vital, and J. Vellard.

1926. Contribuicao ao estudo dos batrachos. Mem. Inst. Butantan, 3(1): 7-70, pls. 1-9.

Chen, K. K., and A. Ling Chen.

1933. Relative susceptibility of the nebulous toad (Bufo valliceps) and the leopard frog (Rana pipiens) to different substances. Jour. Pharmac. Exp. Therap., 47: 295-306.

1933. The physiological action of the principles isolated from the secretion of the South African toad (Bufo regularis). Journ. Pharmacol. Exp. Therap., 49(4): 503-513, fig 1.

1933. The physiological action of the principals isolated from the secretion of the Jamaican toad *(Bufo marinus)*. Journ. Pharmacol. Exp. Therap., 49: 514-525, figs. 1-2.

1933. A study of the poisonous secretions of five North American species of toads. Jour. Pharmacol. Exp. Therap., 49: 526-542, figs. 1-3.

1934. Studies on toad poisons. Arch. Intern. Pharm. Ther., 47(3): 297-317, figs. 1-3.

Hartman, Frank A., and Katharine A. Brownell.
1949. The adrenal gland. Lea and Febiger, Philadelphia. 581 pp. 72 figs.

Junqueira, L. C. U.
1944. Nota sobre a morfologia das adrenais dos ofídios. Rev. Brasil Biol. (Rio de J.) 4(1):63-67.

Maass, T. A.
1937. Gift-tiere. Tab. Biol., 13: 1-272.

Munro, D. F.
1949. Food of *Heterodon nasicus nasicus*. Herpetologica 5: 133.

Mosauer, W.
1935. The myology of the trunk region of snakes and its significance for ophidian taxonomy and phylogeny. Pub. Univ. Calif., 1(6): 81-120, figs. 1-15.

Musgrave, M. E., and Doris M. Cochran.
1930. *Bufo alvarius*, a poisonous toad. Copeia, 173:96-99.

Pope, Clifford H.
1935. The reptiles of China. Nat. His. Centr. Asia (Amer. Mus. Nat. Hist.), 10: lii, 504 pp., 27 pls., 78 figs.

Santos, Eurico.
1942. Anfíbios e répteis do Brasil, Briquet Rio de Janeiro. 280 pp., 57 figs., pls. (color).

Surface, H. A.
1906. The serpents of Pennsylvania. Bull. Div. Zool. Penn. State Dept. Agr., 4(4, 5): 113-208.

Tschambers, Bert.
1948. Death of a snake from toad venom. Herpetologica 4:214.

Uhler, F. M., C. Cottam, and T. E. Clarke.
1939. Food of snakes of the George Washington National Forest, Virginia. Trans. 4th N. Amer. Wildlife Conf., 1939: 605-622.

Valle, J. R. do.
1944-5. The survival of snakes (*Philodryas* sp.) following adrenalectomy. Mem. Inst. Butantan, 18: 237-240.

Valle, J. R. do, and A. Porto.
1944-5. A note on the adrenalin content of the adrenals of snakes. Mem. Inst. Butantan, 18: 247-250.

MUSEUM OF NATURAL HISTORY AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ILLINOIS, URBANA

New and Noteworthy Amphibians and Reptiles from Sinaloa and Puebla, Mexico

By HOBART M. SMITH and RICHARD G. VAN GELDER

For several years Mr. Dyfrig McH. Forbes, at present of Izúcar de Matamoros, Puebla, resided at the village of Costa Rica, 16 km. s. of Culiacán, Sinaloa, where he secured samples of the local reptile and amphibian fauna as occasion permitted. A large part of this collection was lost, but the residue contains a number of noteworthy items.

Several other specimens were secured on a recent visit by the junior author to the Forbes' current residence. Surprisingly enough this small lot contains one new species and a new record for the state of Puebla. We are both greatly indebted to the Forbes for their hospitality, past and present, and for their generosity in accumulating collections for us.

In the following account we list the Sinaloa material first, subsequently the Puebla material. All numbers refer to the University of Illinois Museum of Natural History, where all specimens in these collections are deposited.

Sinaloa

Among the 46 specimens, 18 species are represented. All, except those noted, are from the vicinity of Costa Rica. Species not annotated in the following include *Leptodactylus melanonotus* (Hallowell), *Bufo m. mazatlanensis* Taylor, *Agalychnis dacnicolor* (Cope), *Pternohyla fodiens* Boulenger, *Smilisca b. baudini* (Duméril and Bibron), *Sceloporus clarki boulengeri* Stejneger, *Cnemidophorus sacki communis* Cope, *Heloderma horridum* (Wiegmann) (80 km. N Mazatlán, Sinaloa), *Lampropeltis triangulum nelsoni* Blanchard, *Leptophis d. diplotropis* (Günther), *Oxybelis aeneus auratus* (Cope), and *Crotalus b. basiliscus* (Cope) (6 km. W Costa Rica, Sinaloa).

Iguana iguana rhinolopha Wiegmann. A single adult from Costa Rica, Sinaloa (No. 34933) extends the known range northward over 100 miles from the northernmost locality (Mazatlán) previously recorded.

Ctenosaura pectinata Wiegmann. One juvenile specimen (No. 34953) is from Costa Rica, Sinaloa. It has a minimum of two whorls of small scales between each enlarged whorl, and thus differs very markedly from *C. hemilopha* (Cope) with only one whorl of small scales preceding most enlarged whorls. This specimen requires extension of the concept of the range of this species northward over 100 miles from the nearest locality previously recorded in southern Sinaloa (Mazatlán).

Callisaurus draconoides bogerti Martín del Campo. Two specimens (Nos. 34949-50) extend the range of this subspecies northward over 100 miles from the very limited region (Mazatlán, Isla de Chivos) where it has previously been recorded. This extension corroborates to a certain degree the conjecture (Langebartel and Smith, 1954: 129) that *bogerti* ranges to northern Sinaloa and there intergrades with *C. d. brevipes* Bogert and Dorson.

The specimens agree well with those previously reported. Respectively the male and female measure 63 mm, 47.5 mm, snout to vent; tail,

70 mm., ?; lamellae on 4th toe, 27-29, 28-28; 4th toe, 22 mm., 17 mm.; hind leg, 52 mm., 40 mm.; femoral pores 12-13, ?.

Hypsiglena torquata torquata (Günther). A single male (No. 34924) in a faded and brittle condition, represents this species. The scale rows are 21-21-15; ventrals 159, caudals 57 plus, anal divided; supralabials 8-8, infralabials 10-10; preoculars 2-2, postoculars 2-2; temporals 1-2; posterior chinshields separated (?); mental separated from chinshields; maxillary teeth 9 plus 2; light nuchal collar clearly evident; body blotches not clearly evident throughout, but apparently numbering about 50 (±2); three lateral rows of blotches.

The present specimen together with the data presented by Bogert and Oliver (1945: 379) and the analysis by Tanner (1944: 45) of the distinctive characters of *H. ochrorhyncha* Cope and *H. torquata,* leave no reasonable alternative at the present time to the acceptance of subspecific relationship of these two forms. The most striking difference is in nuchal pattern, but in southern Sonora and northern Sinaloa the two types occur together, although they seem not to blend. Tanner placed greater weight upon the total ventral-caudal counts (or upon caudal counts alone), but these also blend in the same area. Other characteristics listed by Tanner do not closely approach infallibility, and thus an actual blending is difficult to demonstrate without relatively large series from intermediate areas.

Actually the present specimen, like others reported from northern Sinaloa and southern Sonora, may be regarded as representing an intergrade population; this particular specimen shows more similarities to *H. t. ochrorhyncha* than to *H. t. torquata,* as indicated in the accompanying table based upon the distinctions between these two forms pointed out by Tanner. The asterisks indicate the subspecies with which the specimen agrees for each character.

character	*torquata*	*ochrorhyncha*
posterior scale rows	17+	15+*
ventrals and caudals	less than 216	more than 214*
posterior chinshields	separated*	contact
mental-chinshields	contact	separated*
lateral blotches	2 rows	3 rows
caudals	36-47	42-66
light nape band	(♂ 42-47) Present*	(♂ 49-66)* absent

We refer the present specimen to *H. t. torquata* rather than to *H. t. ochrorhyncha* despite the more numerous characters it shares with the latter race, because of the ease of recognizability—the "key" value—of the nape pattern, together with the uncertainty of the status of the *population* as a whole that it represents.

Masticophis flagellum piceus (Cope). Two specimens (Nos. 34914-5) from Costa Rica, Sinaloa, verify the existence of this subspecies in Sinaloa, reported from two other northern localities (Ahome, Altata: Bogert and Oliver, 1945: 403). Ventrals 195♂, 198♀; caudals 100+, 81+, respectively. They are typical "red" racers, lacking any conspicuous dark markings dorsally, and lacking the peculiar lateral nuchal streaks charac-

teristic of *M. lineatus* (Bocourt).

Tantilla yaquia Smith. The single specimen (No. 34921) is from Costa Rica; the species was known previously only from the type, from southwestern Chihuahua. Unfortunately the present specimen is a female (as the type) with an incomplete tail. The ventrals number exactly as in the type (150), the black head cap extends posteriorly over 3 dorsal scale rows, and in most other respects as well it agrees with the type description.

Discrepancies include a separation of mental and chinshields by median contact of anterior infralabials, placement of naris equidistant between upper and lower edges of nasal; a smaller postseminasal (perhaps 2/5 size of preseminasal), absence of a light area at tip of snout and only a very narrow light margin on anterior supralabials, and a narrow frontal. Presumably these discrepancies simply reveal certain individual variations in characters of no diagnostic value within the indicated range. None affect the validity of *T. bogerti* Hartweg, distinguished by fewer caudals (46 in a female) and a more extensive black head cap (covering 4 dorsal scale rows).

Thamnophis cyrtopsis cyclides Cope. Eleven specimens from Costa Rica, Sinaloa (No. 34903-13), agree rather closely with the diagnostic features of this subspecies pointed out by both Smith (1942: 108) and Milstead (1953: 369, 371). The ventrals in the seven males average (157.9) almost exactly the same as Milstead's series (158.6), but in being somewhat less than his figures can scarcely be regarded as intergrades with *T. c. cyrtopsis* (Kennicott) (which has higher counts). The ventrals of females average likewise somewhat less than the overall average for *T. c. cyclides.* The subcaudals in both sexes, on the contrary, average somewhat higher than the overall for *T. c. cyclides,* but the difference between the subspecies in this character is less pronounced than in ventrals.

These specimens thus suggest that the range of *T. c. cyclides* embraces coastal areas as well as the highlands (as originally suggested by Smith *(loc. cit.),* and is not restricted to the Transverse Volcanic biotic province as tentatively concluded by Milstead (1953: 369).

The ventrals in the four females number 152, 153, 154 and 155; their subcaudals are, respectively, 74, 48+, 82 and 78. The ventrals in the seven males are 154, 154, 157, 158, 159, 161, 162; their subcaudals are, respectively, 90, 95, 95, 94, 101, 103, 61+.

Puebla

The 12 specimens available from Puebla represent 7 species. Not annotated are *Ctenosaura hemilopha* (Cope) (14 km. N Izúcar de Matamoros; 1 km. E Chietla), *Sceloporus gadoviae* Boulenger (1 km. E Chietla), *S. h. horridus* Wiegmann (1 km. E Chietla; 3 km. W. Izúcar de Matamoros), *Cnemidophorus s. sacki* Wiegmann (1 km. E Chietla), *Kinosternon integrum* LeConte (2 mi. E Raboso, in cave at a spring) and *Eleutherodactylus cactorum* Taylor (2 mi. E Raboso, in cave at a spring 200 ft. from entrance).

Anolis forbesi sp. nov. Holotype. Univ. Ill. Mus. Nat. Hist. No. 35553, a young male taken by Leora T. Forbes, 5 miles east of Izúcar de Matamoros, Puebla, Dec. 30, 1953.

Diagnosis. A small *Anolis* with the tail rounded in cross-examination; ventrals keeled, very small (about 30 in head length, snout to anterior border of ear); dorsals keeled, very small, grading into laterals, half as large as ventrals, twice size of laterals, about 50 in head length; head longer than tibia; interparietal several times as large as ear opening; upper head scales small, smooth; supraorbital semicircles separated by 1 row of small scales; two rows of 5 enlarged supraoculars each, scales in outer row half size of scales in inner row; postanals not enlarged.

Description of holotype. Head shaped as in *A. nebuloides* Bocourt, width at rear of interparietal 7 mm., length to anterior border of ear (and to rear of interparietal) 9 mm., depth at angle of jaws 5mm.; dorsal head scales smooth, pitted, small; 10 scales on medial line of snout from rostral to the level of the anterior edge of superciliaries; frontal ridges well developed, divergent anteriorly; scales of supraorbital semicircles enlarged, the two series separated by a single row of small scales; enlarged supraoculars in 2 series, the inner row consisting of 5 scales twice as large as the 4 or 5 scales in outer row; 3 rows between interparietal and supraorbital semicircles; interparietal large, oval, twice as long and 3-4 times as wide as ear opening; latter an oblique oval opening; six rows of loreals; suboculars in contact with labials.

Dewlap small, extending posteriorly only a short distance posterior to level of axilla; ventral scales on body and head keeled, small; no crest on body or tail; dorsals uniform, keeled, half size of ventrals, twice size of laterals; preanal scales about size of laterals; no enlarged postanals.

Digital pads moderately developed; 12 lamellae under phalanges 3 and 4 of 4th toe; snout to vent, 31 mm.; foreleg 13.5 mm., hind leg 24 mm.; tibia 7.5 mm.; tail 65 mm.

The preserved specimen is a dark slate-gray above; ventral surfaces dusky, obscurely mottled and speckled, general tone lighter than on dorsal surface.

Remarks. This species does not belong to either of the two common groups of Anoles occurring on Pacific slopes of Mexico north of the Isthmus of Tehuantepec: the *nebulosus* group (all with 1 row of usually 3 enlarged supraoculars) and the *gadoviae* group (all with smooth ventrals). The only other species occurring in this area is *A. cumingi* Peters (actual occurrence questioned), which has enlarged postanals, keeled dorsal head scales and an interparietal the size of the ear opening. Species occurring elsewhere differ in size or keeling of ventrals and caudals, in size of supraoculars, and in other respects. The actual relatives of this species are not clearly indicated at the present time.

The species is named for our mutual friends and hosts, Mr. and Mrs. Dyfrig McH. Forbes of Izúcar de Matamoros, Puebla, who years ago provided a base of operation for field work by the senior author, and more recently enacted a similar role for the junior author.

Masticophis lineatus lineatus (Bocourt). A single specimen (No. 34916) from 8 mi. W Izúcar de Matamoros, Puebla, provides a basis for the first definite record of this species from Puebla, although it has been assumed to occur there. Ventrals 187, male, tail incomplete. The general gray tone and light longitudinal streaks on the lateral nuchal scales are markedly different from the pale reddish coloration of the Sinaloa *M. f. piceus* (Cope).

LITERATURE CITED

Bogert, Charles M., and James A. Oliver.
1945. A preliminary analysis of the herpetofauna of Sonora. Bull. Amer. Mus. Nat. Hist., 83 (6): 297-426, figs. 1-13, pls. 30-37, maps 1-2.

Langebartel, Dave A., and Hobart M. Smith.
1954. Summary of the Norris collection of reptiles and amphibians from Sonora, Mexico. Herpetologica 10: 125-136.

Milstead, William W.
1953. Geographic variation in the garter snake, *Thamnophis cyrtopsis*. Texas Journ. Sci., 5 (2): 348-379, figs. 1-6, pl. 1.

Smith, Hobart M.
1942. The synonymy of the garter snakes *(Thamnophis)* with notes on Mexican and Central American species. Zoologica 27 (304): 97-123.

Tanner, Wilmer W.
1944. A taxonomic study of the genus Hypsiglena. Gr. Basin Nat., 5:25-92, pls. 1-3, map.

MUSEUM OF NATURAL HISTORY AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ILLINOIS, URBANA

NOTES ON ABNORMAL *RANA AURORA DRAYTONI*.—Two specimens of *Rana aurora draytoni* in the U.C.L.A. herpetological collection show abnormalities in the number of limbs. One of these (UCLA 2831) has only a single front leg, with no external indication that another leg was ever present.

The other frog (UCLA 2830) is very unusual in having five legs, the extra limb growing ventrad and caudad from an area slightly cephalic to and one side of the region midway between the two normal hind legs. While one of the normal hind legs measures 86 mm. in length, the extra limb measures only 56 mm. There is no indication of any muscular material in the abnormal limb and it is very lightly pigmented. Webbing is only slightly developed but is present between every toe.

Although growing more from the left side of the frog's body, the abnormal growth is actually a right leg. The normal number of phalanges is present, the fourth being the longest as usual. Cylindrical, peglike, hollow extensions, slightly tapered proximally, and with blunt ends, are present on the terminal phalanges of three toes; they are rather long in proportion to the foot length on the third and fourth toes but very short on the fifth toe.

The general proportion of the extra limb is normal but since it is situated so as to be actually "upside down," it could seemingly have been nothing but a hindrance to survival. Both specimens were collected in temporary pools by Art Lasky in Santa Monica, Los Angeles County, California in 1935. Although no exact ecological data is available, it is quite possible that these abnormalities resulted from excessively high water temperatures in the rapidly diminishing temporary pools.—John D. Cunningham, Department of Zoology, University of California, Los Angeles 24, California.

The Dusky Salamander: Oophagy in Nesting Sites

By JOHN THORNTON WOOD and ROBERT F. CLARKE

On August 27, 1954, a nesting site of *Desmognathus fuscus fuscus X brimleyorum*[1] was found on a mud bar near the dried bed of Washington Ditch about 200 yards west of the point where Rt. 604 crosses the ditch in the Dismal Swamp, Nansemond County, Virginia. The eggs were found in a small crevice beneath a cypress limb imbedded in the mud in an area heavily forested in cypress. The nearest surface water to the nest was a small stagnant pool of dark swamp water about 15 yards away. The nest consisted of a single cluster of eggs suspended by a common stalk from a rootlet traversing the shallow depression in the mud that comprised the floor and walls of the site; the roof consisted of the underside of the cypress branch. When the nest was exposed to observation it was noted that the head of the attending adult specimen was in contact with the eggs and her body was in a curved position above and to one side of the eggs and not in contact with them. This salamander moved little when first seen, and apparently had not been stimulated by any falling fragments of mud or moving rootlets during exposure. When the nest was discovered (4:30 P.M. on an overcast day) the light penetrating the heavy roof of swamp vegetation was not sufficient to stimulate a prompt negative photic orientation; after several minutes of inactivity the female started to walk away down one of the horizontal burrows in the impression of the limb in the mud. The female and eggs were collected and preserved within 30 minutes of discovery.

The nest consisted of 26 eggs that were in early gastrula stage. The snout-vent length of the attending female was 41.0 mm.; her ovaries were devoid of large ova, and her distended and tortuous oviducts were evidence that she had deposited eggs during this nesting season. Since no other nests were found in the area studied it is probable that she was attending eggs she had deposited. Her stomach contents consisted of a lineal series of four eggs complete with egg envelopes; these eggs were identical with those in the nest she attended. This prima facie evidence points to oophagy by this female on eggs of her own species, presumably on eggs she had deposited. The behavior of this female relative to oophagy could not have been induced by previous disturbance of this nest by other observers, a point of some importance in considering Baldauf's (1947) observations.

Baldauf (1947) found a female in a nest site whose stomach contained three eggs. This salamander was collected from a habitat where four discrete egg groups (all attended by adult specimens) had been

[1]*Desmognathus fuscus* in southeastern Virginia are intermediate in characteristics between the subspecies found south of Virginia and *fuscus*. Grobman (1950) believes the taxonomic diagnosis of the populations south of Virginia and north of Florida should be *brimleyorum*, and the authors follow this premise here. However, Eaton (1953) believes his specimens from Pitt County, North Carolina are *auriculatus*, and he points out that practically the only distinctive key character for separation of these subspecies is the light, uniform pigmentation of the belly in *brimleyorum*, and the light or dark but mottled belly of *auriculatus*. Specimens from Dismal Swamp occasionally resemble *fuscus*, frequently resemble *auriculatus*, and often resemble *brimleyorum*. Further study of this problem is in progress.

seen eight days previously. On first observation the crevice in which this salamander was found had contained seven eggs; none remained when the female was collected during the second exposure of the habitat. Because this female was gravid (nine large ova in her ovaries) Baldauf concluded she had eaten the eggs of another individual. The effect of habitat disturbance on the behavior of this female is conjectural but cannot be discounted. Oophagy and the eating of recently emerged larvae of *Desmognathus ochrophaeus carolinensis* has recently been noted in nests not previously disturbed by observers (Wood and Wood, in press).

The factors involved in the behavior of female dusky salamanders in attending nests of eggs of their species are unknown. Noble (1930) suggested that exhaustion was an important factor in this behavior pattern in *Ambystoma opacum*. Exhaustion is a poor explanation, indeed, in the case of *Desmognathus* nests since the attending of the adult can be promptly terminated either by physical stimulation or by photic stimulation. The importance of oophagy as a factor related to the persistence of adult specimens in nesting sites remains to be evaluated.

LITERATURE CITED

Baldauf, R. J.
1947. *Desmognathus f. fuscus* eating eggs of its own species. Copeia, No. 1: 66.

Eaton, T. H., Jr.
1953. Salamanders of Pitt County, North Carolina. Jour. Elisha Mitchell Sci. Soc., 69 (1): 49-53.

Grobman, A. B.
1950. The distribution of the races of *Desmognathus fuscus* in the southern states. Nat. Hist. Miscellanea 70: 1-8.

Noble, G. K.
1930. Probing life's mysteries. Nat. Hist. Mag., Amer. Mus. Nat. Hist., 30 (5): 469-482.

Wood, J. T. and F. E. Wood
1955. Notes on the nests and nesting of the Carolina mountain dusky salamander in Tennessee and Virginia. Jour. Tenn. Acad. Sci. (In press).

UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, VIRGINIA, AND KANSAS STATE TEACHERS COLLEGE, EMPORIA, KANSAS

LOCATION OF THE TYPES OF *BUFO TERRESTRIS CHARLESMITHI*.—In my original description of *B. t. charlesmithi* (Wasmann Jour. Biol. 12(2): 245-254, 1954) I designated specimens from my personal collection (ANB 15-33) as types. Two of these are now Chicago Nat. Hist. Mus. Nos. 33903-4. The others have been deposited in the Stovall Memorial Museum (formerly Univ. Okla. Mus.), Norman, Okla., where they have been assigned numbers as follows: holotype (ANB 32), 26359; paratypes, 26360-77, including two extra paratypes not mentioned in the original paper but used in the study for the original description.—Arthur N. Bragg, Univ. of Okla., Norman.

NOTES ON THE ECOLOGY OF *THAMNOPHIS E. ELEGANS* (BAIRD AND GIRARD).—Above 5000 ft. in the San Bernardino Mountains of Southern California, the Mountain Garter Snake *(Thamnophis e. elegans)* is represented by an isolated population approximately 150 miles south of the main range. Nothing has been published regarding the ecology of this form in its isolated position and it is the purpose of this paper to record certain observations that tend to show that its ecology is, in general, similar to that in its main range.

The Mountain Garter Snake belongs to the terrestrial group of the *Thamnophis elegans* complex and throughout the San Bernardino Mountains it occurs sympatrically with Hammond's Garter Snake, *Thamnophis e. hammondi* (Kennicott), a member of the aquatic group (Fitch, 1940, Univ. Calif. Publ. Zool., 44: 1-150; Fox, 1951, *idem,* 50: 485-530). Although observed by the writer to enter streams occasionally, *T. e. elegans* is far more frequently found in meadow-type vegetation but is also commonly captured in very dry situations miles from water. On one occasion a large adult was observed stretched out on the branches of a *Ribes* almost 3 ft. above the ground. *T. e. hammondi,* on the other hand, is rarely found more than a few feet from water, thus isolating these two subspecies ecologically. Vegetation in this part of its range is predominantly *Pinus ponderosa, Quercus kelloggi,* and *Ceanothus cordulatus.*

Thirty-seven specimens of *T. e. elegans* in the UCLA herpetological collection were examined to determine food preferences. Beetles (47) were in 24.3% of the stomachs; *Bufo boreas halophilus* (22) in 21.6%; *Hyla regilla* (12) in 10.8%; *Sceloporus graciosus vandenburgianus* (7) in 10.8%; ants (2), and spiders (2), each in 5.4%; and a bird (1) in 2.7%. Excluding those snakes known to have been kept in captivity, 54% had identifiable matter in their digestive tracts. This is a considerably higher percentage than is reported for other species of *Thamnophis* (Fouquette, 1954, Texas Jour. Sci., 6: 172-188). In addition, gravel and bits of plant matter were present in most stomachs. Most of the beetles were carabids, coccinellids and tenebrionids. All of the *Bufo boreas* were juveniles and were found in the stomachs of snakes captured at Bluff Lake (7700′) and Dry Lake (8900′). The snakes analyzed had been captured between June and September, most commonly in July. As a rule, this subspecies eats well in captivity and usually if *Bufo boreas, Hyla regilla* or *Sceloporus graciosus* are in the same container with one of these snakes, they will be consumed.

Little is known concerning the reproduction of the Mountain Garter Snake in this part of its range. On June 20, 1954, the writer captured a large female near Big Bear Lake (6700′) which contained 11 eggs; their average size in alcohol was 11.4 x 8.9 x 7.4 mm. A gravid female (UCLA 2569) was captured going down a *Thomomys* burrow near Lake Arrowhead (5700′) on July 30, 1941. Four young (UCLA 2570-2573) were born to this snake the following October 11.

Likewise, few data are available concerning the temperature tolerances of this subspecies. At 11 a.m. on September 7, 1952, at Dry Lake, three of these snakes were captured while foraging for *Bufo boreas* with body (anal) temperatures of 31.2°, 26.0° and 27.2° C., respectively.—John D. Cunningham, Department of Zoology, University of California, Los Angeles 24, California.

ULTRAGULOSITY IN THE FROG *RANA AURORA DRAYTONI*.—An 87 mm. (snout-vent) *Rana aurora draytoni* Baird and Girard secured May 29, 1950, at San Ramon, California, proved unusually voracious during its two years of captivity. It swallowed almost every moving creature in its quarters, including an *Acris gryllus* (Le Conte) and a bullfrog tadpole 4 inches in length. Its greatest feat (August, 1952) was the ingestion of a toad, *Bufo boreas halophilus* Baird and Girard measuring 58 mm. (snout-vent), captured at Alamo, California. The inflated toad was wider than the frog, greatly impeding deglutition. In one hour the frog had just reached the axillary region of the toad, which was still very lively and fully inflated. In two hours the toad had given up the struggle, had been deflated, and only the hind legs protruded from the frog's mouth. When the ordeal was over, the frog's legs scarcely touched the ground and the toad caused a grotesque asymmetrical protrusion from the frog's abdomen. Apparently no serious digestive disturbance ensued, for other food was taken later the same and the following month. The frog died, however, on September 24, 1952, of unknown causes.—M. Richard Hays, 11 Ranch Road, Orinda, California.

THE RANGE OF THE CAVE SALAMANDER IN ILLINOIS.—Although widely distributed in southern Illinois, *Eurycea lucifuga* (Rafinesque) has been reported up to the present time from Monroe, Jackson and Union counties. Investigations during the past four years have revealed occurrence at the following localities: Sifford Spring, Guthrie Cave, Cobden Cave and Rich Cave, all near Cobden, Union Co., Oct. 24, 1952, and July 7, 1953; a cave in Giant City Park, Jackson Co., June 23, 1953; a cave near Equality, Gallatin Co., May 1, 1938, and June 16, 1953; well house in Union County State Park, May 1, 1953; stream and spring at Pine Hills, Union Co., June 21, 1951, Oct. 1, 1951, April 20, 1952, Mar. 27 and Apr. 18, 1954; Ferne Clyffe, Goreville, Johnson Co., July 15, 1951; Kincaid Cave, Jackson Co., July 15, 1953; Humms Wye Stream, Ill. State Route 34, Rosiclaire, Hardin Co., April 24 and Oct. 30, 1954; a cave near Chester, Randolph Co., April 6, 1938; and a cave near Alto Pass, Union Co., April 26, 1938.

The range of this species is thus known to extend across the entire southern part of the state in the Ozark uplift, and is not disjunct as indicated in Bishop's Handbook of Salamanders.—Hilda A. Stein, Southern Illinois University, Carbondale.

Notes on Mexican Toads of the Genus Tomodactylus With the Descriptions of Two New Species

By WILLIAM B. DAVIS and JAMES R. DIXON

Among the amphibians in the Texas Cooperative Wildlife Collection (TCWC), which were collected in Guerrero by field parties from the Department of Wildlife Management, Texas A. and M. College, in 1952, 1953, and 1954, are a number of specimens of *Tomodactylus* from elevations between 2700 feet and 8000 feet within a radius of 30 miles of Chilpancingo. Dr. Hobart M. Smith also sent us on loan from the University of Illinois Museum of Natural History (UIMNH) several specimens from that area. These segregate into three distinct groups.

One is a small, slender, delicate form with large reddish or orange spots on the anterior face of the femur near the groin and on the posterior surface of that member near the knee, with the tips of the two outer fingers distinctly broadened and truncate, and with a distinct light line on the upper lip. E. H. Taylor in 1943 named this form *T. alholabris*. Its known range is on the coastal slope of the Sierra Madre del Sur in the mixed pine-oak forest between Mazatlán and Agua del Obispo at elevations from 2700 ft. to near 4000 ft. We have examined 45 specimens referable to this species from Acahuizotla and Agua del Obispo. Taylor (1943) records it also from a locality 9 km. S Mazatlán, which is only a few kilometers north of Agua del Obispo, the type locality, and in the same valley.

A second group is comprised of moderately large (s-v length 25.0-31 mm.), grayish frogs with the tips of the two outer fingers only slightly expanded, a rounded canthus, a relatively large tympanum (0.9-1.0 mm.) separated from the eye by a distance equal to or less than the tympanic width, and white anterior and posterior parts of the femur stippled with black, not immaculate. This population is obviously assignable to *T. nitidus* (Peters) as known to us by specimens from the drier inland parts of Morelos, Puebla, Oaxaca and Veracruz. This group occupies the arid areas north of the Río Balsas and the lower, drier foothills and valleys near Chilpancingo, which appear to be faunal outposts of the Balsas Basin.

Specimens from Amula (= Almolonga) were described by Günther (1900) as *T. amulae* but Kellogg (1932), following the lead of Parker (1927), pointed out that there is little basis for distinguishing *amulae* from *nitidus* and, consequently, he submerged the name *T. amulae* as a synonym of *T. nitidus*.

Miss Alice G. C. Grandison, Department of Zoology (Reptiles and Amphibians) of the British Museum of Natural History has compared seven freshly preserved specimens from Almolonga (= Amula) which we sent her and has written Davis (September 15, 1954) as follows: "There is no doubt that your seven specimens are *Tomodactylus nitidus* (= *amulae*) and they agree perfectly with the cotypes of *amulae*. In the types the first finger is a little shorter than the second and not equal to the second as Günther said. It is difficult from Günther's description to judge what colour his specimens were in life; now they are badly faded but remnants of pattern indicate a similarity to your Amula material and the

degree to which the dorsal tubercles are developed is much the same."

After comparing a large series of topotypes of *amulae* with near topotypes of *nitidus* (from eastern Morelos and western Puebla), we, too, find no valid reason for recognizing the Guerreran population as different from "typical" *nitidus* except that specimens from the foothills west of Chilpancingo and from the vicinity of Colotlipa are noticeably larger and have a longer hind foot. Even so, they can be referred to *nitidus* with little hesitation.

We have examined 76 specimens that are assignable to *nitidus* from the following Guerreran localities: 2½ mi. S. Almolonga, 5600 ft., 24 (TCWC); 4 mi. W Chilpancingo, 5800 ft., 3 (TCWC); 3 mi W Chilpancingo, 5000 ft., 1 (TCWC); 2-5 mi. S Chilpancingo, 4 (UIMNH); 1 mi. SW Colotlipa, 2700 ft., 2 (TCWC); 2 mi. N Mazatlán, 2 (UIMNH); Mazatlán, 1 (UIMNH); Palo Blanco, 2 (UIMNH); 2 mi. E Taxco, 5500 ft., 6 (TCWC); 17 km. S Taxco, 4000 ft., 3 (TCWC); 8 km. N Taxco, 5500 ft., 27 (TCWC); Tixtla Lake, 1 (UIMNH); also 112 specimens from several localities in Morelos, Puebla, and Oaxaca.

A third group is a dark (blackish or brownish upper parts), robust form found at high elevations and usually with a large, conspicuous, immaculate ochraceous spot on the inner proximal face of the femur and another on the posterior face in the bend of the knee. The tips of the two outer fingers are conspicuously expanded and truncate; tympanum small (diameter 0.70 mm. to 1.0 mm. in males) and separated from the eye by a distance slightly greater than the tympanic width; snout paler than rest of head and body; distinct dark stripe through eye from the nostril to the shoulder area. Since this population appears to represent an unnamed species, we propose that it be known as

Tomodactylus dilatus[1] sp. nov.

Holotype. TCWC No. 11245, male, from four miles west of Mazatlán, 7400 feet, Guerrero; collected June 18, 1953, by James R. Dixon, original number, 2565.

Paratypes. TCWC Nos. 11246-51 from the type locality; TCWC Nos. 10211-19, 4 mi. W Mazatlán, 8200 ft.; TCWC Nos. 10196-210, 2 mi. SW Omiltemi, 7900 ft.

Diagnosis. A moderately robust *Tomodactylus*, 25 mm. to 30 mm. in snout-vent length (females larger than males), with tips of the two outer fingers truncate and conspicuously dilated laterally; tympanum varying from 0.7 mm. to 1.0 mm. in horizontal diameter in males (1.5 mm. in the single female) and separated from the eye by a distance slightly greater than tympanic width; canthus appearing sharp angled; heel to about middle of eye; heels overlap about one millimeter with legs folded at right angles to body; upperparts pustulate, varying from lavender to brownish in life, mottled with blackish; underparts granular, varying from heavily pigmented and with numerous white subcircular spots to nearly white, but faintly peppered with pigment (visible under a lens); usually a distinct, dark loreal stripe from nostril to eye, which continues posteriorly above

[1] In allusion to the broadly expanded tips of the digits, especially of the outer two of the manus.

tympanum onto shoulder; lumbar gland distinct, elongate and blackish in color bordered below by a white patch; large ochraceous (white in preserved specimens) spot on anterior proximal face of the femur and another posteriorly in the bend of the knee; tibia usually with three (occasionally two) transverse bars; femur with at least one distinct transverse bar, at most three.

Comparisons. Differs from *T. nitidus* in much darker dorsal coloration; two outer fingers with tips expanded to nearly twice the width of the subterminal phalanges, rather than slightly expanded; venter, when spotted, with whitish rather than brownish spots. Differs from *T. albolabris* in more robust size; ochraceous rather than orange inguinal and postfemoral spots; absence of light stripe on upper lip. Differs from *T. petersi* chiefly in ochraceous rather than orange inguinal and postfemoral spots; underparts pigmented and dotted with white flecks, rather than white with large dark flecks; inguinal gland distinct and elevated rather than diffuse and inconspicuous; tips of outer two fingers conspicuously expanded.

Remarks. The following notes were taken by James R. Dixon in the field and are based on living animals.

"June 21, 1954. 4 mi. W Mazatlán, Guerrero, Mexico, El. 7800 ft. Collected between the hours of 8:00 p.m.-10:00 p.m. Seven *Tomodactylus* were collected in small shrubs and pines from 2 to 7 feet in height. The call is a peep and trill. Sometimes a five-note trill.

"A median dorsal dermal fold from interorbital region to the anus; ground color grey, mottled with overall grey-green. [Other live specimens Davis has seen from the same locality were nearly chocolate brown dorsally.] An interorbital stripe of ground color. The tympanum small, indistinct in some. A dark stripe from snout through nostril, middle of eye, over the tympanum and to just over the insertion of the shoulder. Lumbar gland large, as long as humeral region of forearm. Hind limbs ground color, barred with dark brown above. Femoral region with yellow ochre mottling, both anteriorly and posteriorly, continuing on to the tibial region ventrally. Chin with few white punctations along the infralabial region. Belly with some white tipped granulations, ventral femoral region granular with few white punctations and flesh color; sides sometimes granular. The lumbar gland mostly black, blotched with white, large irregular white blotch below inguinal gland continuing ventrally to the granulated area of belly. Enlarged light area along mid-dorsal line, equal distance between snout and anus. Three palmar tubercules, one enlarged, two small, perhaps four in some cases. Two outer toes enlarged, truncate at tips, enlarged about 1½ times the width of the narrowest part of digit. Tips of other toes enlarged but not as much. Hind foot—tips of inner four toes enlarged, 5th only barely so; eye color almost same as body, grey-green above, near black below; tongue rounded at tip; heel reaches posterior margin of eye or between tympanum and eye."

One specimen, TCWC No. 11261, collected at Agua del Obispo by Ralph Axtell cannot be assigned to any of the common species of *Tomodactylus* known from Guerrero. It differs from *T. albolabris,* which also occurs at Agua del Obispo, in (1) larger size, (2) lack of whitish line on upper lip, (3) longer forearm, (4) absence of dilated tips of digits.

From *T. nitidus* it differs in (1) slenderer build, especially the forearm, (2) manus about half as big, (3) dorsum smooth and dark brown, etc. From *T. dilatus* it differs conspicuously in (1) smooth dorsum, (2) forearm much slenderer and manus and pes much smaller, (3) tips of digits not expanded. It resembles *T. angustidigitorum* from Michoacán in having small feet and hands and slender forearms, but the eye is considerably larger, the dorsum and venter are smooth, and conspicuous light blotches are on the anterior and posterior faces of the femur (femur concolor in *augustidigitorum*).

Dixon recognized the toad as different from others in the area when it was captured and wrote the following notes at that time. "*Tomodactylus* sp. Call: a long buzz, not a trill or peep. Color: dorsal pattern almost black with ground color of metallic gray, blotches of black almost blot out ground color; front and rear legs banded; upper and lower labials of same color; eye color metallic gray-green; venter mottled with black on white, sides of belly areolate; posterior surface of femur aerolate; *orange ochre blotch on anterior surface of thigh in region of groin*, blotch continues to posterior surface of thigh; inguinal gland medium in size and rather indistinct, bordered on bottom by black, the gland a little shorter than forearm, length 5 mm.; total length of specimen 25 mm.; dark area from snout through eye over tympanum to shoulder. Tips of digits not greatly expanded. Tympanum about ¼ size of orbit. Throat and pectoral region skin color stippled with black."

Among named populations, this specimen is most like *Tomodactylus petersi*, which Duellman (1954) recently described from Michoacán. It agrees in the following respects: (1) skin relatively smooth; (2) dorsum dark brown; (3) inguinal gland small and rather indistinct; (4) femoral patches orange in color (now white in preservative); and (5) tips of digits of manus not greatly expanded. It differs, however, in having smaller hands and tympana. These minor differences plus the geographic barrier of the arid Balsas Basin which separates the known range of *petersi* in Michoacán and the Sierra Madre del Sur in Guerrero cause us to question the allocation of this specimen to *petersi*, but until additional information dictates some other course, this allocation seems best for the present.

Several specimens of *Tomodactylus* in the Texas Cooperative Wildlife Collection from the Sierra Ajusco south and southwest of Mexico City in the states of México and Morelos cannot be assigned to any of the currently recognized species. These toads are small, with slender arms and small hands, and resemble superficially the form E. H. Taylor named *T. angustidigitorum*. But they differ in several respects, especially in having the tips of the two outer fingers expanded and truncate. Because they appear to be distinct and lack a name, we propose that they be known as

Tomodactylus fuscus[2], sp. nov.

Holotype. TCWC No. 11252, male, from 1½ miles southeast of Huitzilac, 7800 feet, Morelos, México; collected June 27, 1954, by James R. Dixon.

[2] In allusion to the dusky brown color.

Paratypes. TCWC Nos. 11253-56 and 8548-50 from the type locality; TCWC Nos. 11257-60 from 4 mi. N Tenancingo, 8200 ft., Mexico.

Diagnosis: A small (s-v length 25-27 mm.), dark brown member of the genus with tips of the two outer fingers expanded and truncate; tympanum small and inconspicuous; inner metatarsal tubercle nearly twice as large as outer; forearm slender and hand relatively small; heel reaching posterior corner of eye with hind leg laid forward; lumbar gland conspicuous, elongate; femur more or less uniform brown anteriorly and posteriorly; abdomen granular; dorsum with scattered pustules.

Comparisons: Appears to be most closely allied to *T. angustidigitorum*, judging from size and coloration, but differs in (1) tips of two outer fingers expanded and truncate, not tapering and narrow, (2) inner metatarsal tubercle conspicuously larger than outer, rather than sub-equal, (3) hind foot longer in animals of comparable body size. Differs from *T. nitidus* in the adjacent lowlands in (1) brownish rather than mottled grayish dorsum, (2) less robust, with slenderer forearm and small hands and feet, (3) dorsum less pustular; (4) anterior, dorsal, and posterior faces of femur nearly uniform brown, rather than blotched and spotted; (5) cross bars on legs usually obscure, rather than conspicuous. Differs from *T. petersi* in (1) absence of orange blotches on thighs and groin, (2) smaller, inconspicuous tympanum, rather than distinct and equal to half the diameter of the eye, (3) transverse bands on femur, tibia, and tarsus usually obscure, rather than distinct, (4) venter buff rather than cream. Differs from *T. dilatus* in (1) femur nearly uniform brown, rather than with large ochraceous blotches on front and rear faces, (2) much smaller in size and with proportionately slenderer forearms, (3) dorsum much less pustular, (4) venter buff, rather than whitish, (5) heel to middle of eye rather than to tympanum. Differs from *T. macrotympanum* most conspicuously in (1) much smaller size and (2) much smaller tympanum.

Remarks. The identity of the *Tomodactylus* inhabiting the higher parts of the Ajusco range south of Mexico City has been uncertain for a number of years. Smith and Taylor (1948), without having the benefit of examining the type or topotypes of *T. amulae*, referred specimens from Tres Cumbres, Morelos, to that species. Davis and Smith (1953) were hesitant to assign the three specimens available to them from near Huitzilac to any of the then recognized species. Now that topotypes of *T. amulae* are available for comparison, it is evident that the population from the Sierra Ajusco cannot be assigned to *T. amulae*, which name is a synonym of *T. nitidus*. Nor can it be assigned to the closely related *T. angustidigitorum* for reasons pointed out above. We have considered the possibility that *angustidigitorum* and *fuscus* are geographic races of a single species, but have discarded that view because both forms occur together near Tenancingo.

Two of our three specimens collected at the type locality in 1949 were found at night calling from the tops of rocks; the other was found in the daytime under a rock. The five specimens collected there in 1954 were found at night off the ground in small bushes. The call is a single peep given at long intervals which, coupled with their shyness, makes these toads difficult to locate and capture.

DIAGNOSTIC KEY TO THE SPECIES OF TOMODACTYLUS

1. Tips of two outer fingers conspicuously expanded and truncate, one and one-half to twice narrowest width of digit 2
   Tips of two outer fingers not noticeably expanded and not more than one and one-fourth narrowest width of digit 4

2. Tympanum large and conspicuous, its horizontal diameter equal to about three-fourths diameter of eye; size large (s-v length to 31 mm.); dorsum grayish; venter whitish; anterior face of femur with yellowish or whitish area, rear of femur pigmented—*T. macrotympanum.*
   Tympanum small and obscure, its horizontal diameter less than half the diameter of eye 3

3. Size large (s-v length to 30 mm.); upperparts mottled dark gray or dark brown; large immaculate ochraceous spots on anterior and posterior faces of femur; underparts usually pigmented and with whitish subcircular spots; upper lip pigmented—*T. dilatus.*
   Size small (s-v length to 23 mm.); upperparts olive to olive brown; red or orange spots on anterior and posterior faces of femur and sometimes in groin; venter whitish with diffuse dark spotting; upper lip with whitish line—*T. alholabris.*

4. Hand small; tips of fingers tapering and narrowest at tip; size small (s-v length to 25 mm.); upperparts slightly tuberculate, mottled brownish; venter buff; tympanum variable but usually conspicuous; anterior and posterior faces of femur uniform brown—*T. angustidigitorum.*
   Hand large; tips of fingers as wide as or slightly wider than narrowest part of finger 5

5. Size large (s-v length to 30 mm.); tips of fingers may be slightly dilated; upperparts pustulate, mottled greenish gray; venter whitish; tympanum small, inconspicuous; anterior face of femur and sometimes groin with immaculate white splotch—*T. nitidus.*
   Size small (s-v length to 26 mm.); tympanum about one-half diameter of eye; dorsum chocolate brown to greenish brown; venter whitish with scattered dark spots; bright orange spots on anterior and posterior faces of thigh and in groin—*T. petersi.*

LITERATURE CITED

Davis, W. B., and H. M. Smith

1953. Amphibians of the Mexican state of Morelos. Herpetologica, 8:144-149.

Duellman, W. E.

1954. The amphibians and reptiles of the Jorulla Volcano, Michoacán, Mexico. Occ. Papers Mus. Zool. Univ. Michigan, 560: 1-24, 1 fig., 2 pls.

Günther, A. C. L. G.

1900. Biologica Centrali-Americana, Reptilia and Batrachia. pp. 219-220.

Kellogg, Remington

1932. Mexican tailless amphibians in the United States National Museum. Bull. U. S. Nat. Mus., 160:iv/224, 24 figs., 1 pl.

Parker, H. W.

1927. A revision of the frogs of the genera Pseudopaludicola, Physalaemus, and Pleuroderma. Ann. and Mag. Nat. Hist., Ser. 9, 20:450-478, 5 figs.

Smith, H. M., and E. H. Taylor

1948. An annotated checklist and key to the amphibia of Mexico. Bull. U. S. Nat. Mus., 194:iv/118.

Taylor, E. H.

1943. Herpetological novelties from Mexico. Univ. Kans. Sci. Bull., 29(8):343-360, pls. 26-27.

DEPARTMENT OF WILDLIFE MANAGEMENT,
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A POSSIBLE SNAKE HIBERNACULUM.—In view of the scarcity of information on the hibernating habits of western snakes, the following observations are submitted. On October 4, 1941, Mr. Ervin Woods and I investigated a certain 40-acre clearing around long-abandoned ranch buildings 7 miles south and 2 miles west of Philomath, Benton County, Oregon. Closely pastured and sloping gently toward the south, the clearing was surrounded by second-growth fir forest.

Our attention was drawn to a decaying fir stump by the presence of several snakes at its base. Closer examination revealed four ring-necked snakes, *Diadophis amabilis* Baird and Girard, coiled about one another. Considerable portions of their orange underparts were exposed, but unfortunately the snakes were captured before the significance of their position was ascertained.

In addition to the *Diadophis*, a small yellow-bellied racer (*Coluber constrictor mormon* Baird and Girard) was captured as it attempted to enter an opening in the stump. Further search revealed two additional species: a small gopher snake, *Pituophis catenifer* (Blainville) was taken from beneath a piece of bark adjacent to the stump, and 3 rubber boas, *Charina bottae* (Blainville) all about 10 inches in length, were discovered in cracks within a moister portion of the stump.

This stump was approximately 3 feet in diameter and projected some 8 inches above the ground. It was beginning to decay and contained many cracks and crevices, but was still fairly sound. Several small burrows led downward into its root system. There were no similar stumps to be found in the area.

It seems quite possible, due to the lateness of the season, that all 4 of the species encountered would have hibernated here, utilizing burrows and crevices in the stump and its roots to reach suitable underground levels.—Robert M. Storm, Zoology Department, Oregon State College, Corvallis, Oregon.